# REFERENCE REVERSALS AND THE ANALYSIS OF INCOME DISTRIBUTIONS*

by

Yoram Amiel
The Rupping Institute, Israel

Frank A Cowell
London School of Economics and Political Science

Liema Davidovitz
The Rupping Institute, Israel

Avraham Plovin
The Rupping Institute, Israel

Discussion Paper
No. DARP 66
March 2003

Distributional Analysis Research Programme
The Toyota Centre
Suntory and Toyota International
Centres for Economics and
Related Disciplines
London School of Economics and Political Science
Houghton Street
London WC2A 2AE
Tel.: 020-7955 6678

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* We are grateful for helpful comments from Peter Dolton, Graham Loomes, Dirk van der Gaer, and seminar participants at the London School of Economics and the University of Gent. We also thank Guillermo Cruces for computational assistance.

## Distributional Analysis Research Programme

The Distributional Analysis Research Programme was established in 1993 with funding from the Economic and Social Research Council. It is located within the Suntory and Toyota International Centres for Economics and Related Disciplines (STICERD) at the London School of Economics and Political Science. The programme is directed by Frank Cowell. The Discussion Paper series is available free of charge and most papers are downloadable from the website. To subscribe to the DARP paper series, or for further information on the work of the Programme, please contact our Research Secretary, Sue Coles on:


| | |
|---|---|
| Telephone: | UK+20 7955 6678 |
| Fax: | UK+20 7955 6951 |
| Email: | s.coles@lse.ac.uk |
| Web site: | http://sticerd.lse.ac.uk/DARP |

## Abstract

It is known from the literature on uncertainty that in cases where individuals express a preference for a high win-probability bet over a bet with high winnings they nevertheless will bid more to obtain the bet with high winnings. We investigate whether a similar phenomenon applies in the parallel social-choice situation. Here decisions are to be made between a distribution with a small group of very high-income people. Results from a number of experimental designs are analysed.



**Keywords**: Preference reversals, Social welfare, Inequality, Risk and Experiments.

**JEL Nos.:** D63, D81 and C91





Contact address:
Professor Frank Cowell, STICERD, London School of Economics and Political Science, Houghton Street, London WC2A 2AE. Email: f.cowell@lse.ac.uk

There is a well-known similarity between the standard economic approaches to the analysis of risk and of inequality. Judgments on income distributions in terms of inequality can be analysed using the same tools as judgments on a probability distribution with monetary payoffs in terms of risk. The analogy between the two lies at the heart of much of modern welfare economics. The connection between the economic analysis of risk and the modelling of individual utility under uncertainty is mirrored in the relationship between inequality and social welfare. Moreover, in many cases, the standard theories applied to the analysis of distributions in either context suffer from the same sort of shortcomings. This paper focuses on a particular difficulty that has long been highlighted in the literature on risk and uncertainty, but which has been neglected in the application of risk analysis to the problem of making social choices when there is a concern for inequality.

The essence of preference reversals can be seen as a dysfunction between different aspects of the theory of choice – one that has important implications for the way in which economic models of choice under risk are applied. It could be that the same kind of preference-reversal phenomenon that has been noted in a variety of contexts involving risky choices also affects situations involving social choices among income distributions. A question that has not been addressed hitherto is whether there is prima facie evidence for this dysfunction in the ranking of income distributions.

In this paper we investigate whether the phenomenon of preference reversals, well established in the context of risk theory, also applies when people make their decisions in the context of income-distribution comparisons. We show how a suitable experimental test may be constructed and discuss the results of running this experimental design in a number of countries. Section 1 provides an overview of the preference-reversal issue as it has emerged in the literature on risk and uncertainty and section 2 discusses the way in which the issues translate to the welfare-economic analysis of income distribution. Section 3 outlines our experimental approach and Section 4 presents the main results.

# 1 Background: Risk

The preference reversal (PR) phenomenon is well described by Slovic and Lichtenstein (1968).[1] In their experiments, people were asked to choose between two pairs of bets. In each pair, one bet had a higher probability of winning (the "P bet"); the other offered higher sum to win (the "$ bet"). The results showed that when the P bet was chosen, the $ bet often received a higher bid.[2] The results are not special to laboratory experiments: gamblers in a Las Vegas casino were found to employ different strategies when choosing among pairs of bets than when attaching monetary values to single bets (Slovic and Lichtenstein 1983).

## 1.1 Explanations and persistence of PR

PR is widely documented in the psychology literature and to some extent has been addressed by economists as well.[3] Why might it arise? A variety of reasons have been advanced that draw upon both economics and psychology literature.

- Where real money is involved, incentives may have been misspecified.
- If there are substantial gains and losses then it is possible that some apparent PR behaviour is in fact just a simple income effect. More subtly people may require more to give up an object than they are willing to pay to acquire it – the so-called *endowment effect* (Thaler 1980).
- Preferences may be intransitive (Fishburn 1985, Loomes et al. 1991).

[1] Amongst many other previous contributions note particularly those of Tversky (1967, 1969). See Seidl (2002) for a comprehensive survey.

[2] Although in our questionnaire study below the counterpart of the $ bet is Lorenz-dominated by, and has a higher mean than, the counterpart of the P-bet, the simple definitions of the two sorts of bet do not in general imply that the $ bet has to be riskier in Rothschild-Stiglitz terms and have higher mean than the P-bet.

[3] See in particular Slovic and Lichtenstein (1983) and the recent survey by Seidl (2002). Roth (1991) describes experiments in which animals have been observed to exhibit some choice anomalies of the same kind.

- People can and do make inconsistent choices under uncertainty and may be sensitive to the way a problem is presented – the *framing effect* (Davis and Holt 1993).

- A standard psychological argument focuses on the processing the information contained in the lotteries: decision-makers use one part of the information when they compare the lotteries, and another part when they determine their monetary value (Safra et al. 1988). Indeed Slovic and Lichtenstein's own explanation was that in bidding the decision-maker starts with a specific amount to win, and adjusts it downward to account for other attributes of the bet. In the choice problem there is no natural starting point. Thus the amount to win dominates the bid decision but not the choice decision.

Grether and Plott (1979) designed an experiment which controlled for all the economic-theoretic explanations of the phenomenon, and found that PR persisted. They concluded:

> In a sense the exception is an important discovery, as it stands as an answer to those who would charge that preference theory is circular and/or without empirical content. It also stands as a challenge to theorists who may attempt to modify the theory to account for this exception without simultaneously making the theory vacuous.

Pommerehne et al. (1982) and Reilly (1982) followed the Grether and Plott (1979) design, motivated by skepticism of the PR phenomenon and a belief that, examined under proper conditions, it might disappear. Although the incidence of PR was somewhat lower than that observed by Grether and Plott (1979), the phenomenon could not be eliminated.

## 1.2 The preference model

PR belongs to broad class of findings that appear to demonstrate preference patterns inconsistent with the axiomatic basis of Expected Utility (EU) – the standard model of decision-taking under risk.[4] It is natural that there should be focus on the individual axioms of EU that might drive the PR phenomenon.

Clearly intransitivity, noted above, could be a candidate explanation. Furthermore PR could arise from violations of the independence axiom (Cox and Epstein 1989, Karni 1990): if the independence axiom of EU is not satisfied, then the lottery choice and the selling price elicitation decision are no longer separable as would be the case in EU analysis (Holt 1986). In this context a principal explanation for violations of the independence axiom, is the *anchoring* phenomenon where a person's judgments or decisions are affected by some reference level of income or wealth.

It is appropriate to consider whether some alternative to the standard EU model could provide a coherent framework of choice under uncertainty consistent with the PR phenomenon. For example prospect theory suggests that people underweight outcomes that are merely probable in comparison with outcomes that are obtained with certainty (Kahneman and Tversky 1979). This can lead to inconsistent preferences when the same choice is presented in different forms.[5]

However Tversky et al. (1990) argue that PR cannot be adequately explained by violations of independence, transitivity or indeed the reduction axiom: rather the primary cause of PR is the failure of "procedure invariance,"[6] especially the overvaluing of low-probability high-payoff bets. Some reversals are explained by scale compatibility, which implies that payoffs are weighted more heavily in pricing than in choice.

Some, but not all, of these conclusions may be expected to

[4] The mechanism used for the preference reversal experiment will only elicit the certainty equivalent in the case of EU (Karni and Safra 1987).

[5] Prospect theory predicts risk-averse behaviour in choices involving sure gains, and risk seeking in choices involving sure losses. Furthermore people may discard components that are shared by all prospects under consideration. According to the theory value is assigned to *gains and losses* rather than to final assets and in which probabilities are replaced by decision weights. The value function is usually concave for gains, convex for losses and is steeper for losses than for gains.

[6] "Procedure invariance holds whenever the decision maker prefers a bet $B$ to a cash amount $X$ if and only if the selling price for $B$ exceeds $X$." – (Tversky et al. 1990).

carry over to the income-distribution context.

# 2 Preference Reversals: Income Distribution

As we noted in the introduction, there is a link between the issues concerning the private choice in the face of uncertainty and social choice amongst alternative income distributions. The basis for this link may be taken as one defined in purely formal terms – whereby the structure of the mathematical model for one problem is grafted on to the analysis of another – or one in which the same axiomatic basis is used to characterise, for example risk and inequality – see Rothschild and Stiglitz (1970, 1971, 1973), Nermuth (1993). At a deeper level one can model the choice between income distributions as though an individual were making a choice amongst random prospects behind a veil of ignorance as in Harsanyi (1955).

Of course policy makers and lay people may not make an explicit connection between the two types of analysis. They may make reference to some concept of "inequality" in general but make only a vague connection between it and risk or to other criteria by which one might judge economic performance. However it is reasonable to suppose that there could be some linkage between the considerations that underlie the formulation of a utility function as a tool for appraising risky choices and the considerations that underlie the application of a social-welfare function (SWF) to the appraisal of unequal income distributions; at the least one could posit that the same kind of ranking structures may apply to both types of distributional problems. Given that a connection is explicitly or implicitly made between rankings of income distributions and rankings of prospects, the issue arises whether the same kind of preference-reversal is likely to be observed in situations involving social choices amongst income distributions. If so there may be important implications for the use of SWF analysis as a guide for policy-making.

The issue can be expressed using standard approach in the inequality literature formalised by, for example, Atkinson (1970), Kolm (1969) and Sen (1973). Consider the problem of comparing two income distributions $F_1$ and $F_2$. It is common to assume the existence of an individualistic social welfare function $W$ defined on the space of income distributions that is endowed with properties such as continuity, monotonicity, the transfer principle, decomposability by subgroups. This, if appropriately specified, forms the counterpart to the expected-utility function in the problem of choice under uncertainty. Clearly, the cardinalisation of $W$ is arbitrary and for this reason it is common practice to introduce the equally-distributed equivalent income $\xi$ of a distribution $F$. This clearly is the counterpart to certainty-equivalent income: $\xi_0 = \xi(F_0)$ is that income which, if received by everyone in a perfectly egalitarian distribution, would yield the same level of social welfare as $W(F_0)$ – see Figure 1.

So for two income distributions $F_1$ and $F_2$ one would regard the statement

$$W(F_1) \geq W(F_2) \tag{1}$$

as equivalent to the statement

$$\xi_1 \geq \xi_2. \tag{2}$$

Therefore, if one were able to pose a question as to the *social* choice between two distributions and $F_1$ were (hypothetically) chosen rather than $F_2$, one would expect there to be some revealed valuation $\xi_1$, $\xi_2$ of the two distributions where $\xi_1 > \xi_2$

However could one conceivably find the contrary in practice? If so, then the implied social-welfare version of the preference-reversal phenomenon raises some interesting questions:

- Do people's perceptions of income distribution violate the continuity assumption required for the construction of the equally-distributed equivalent income $\xi$?
- Do people perceive a priority of need?
- Would there be a special case if there were a large proportion of the population at a subsistence income level?
- As in the case of experiments involving choices under uncertainty, do people's perceptions and/or choices violate the

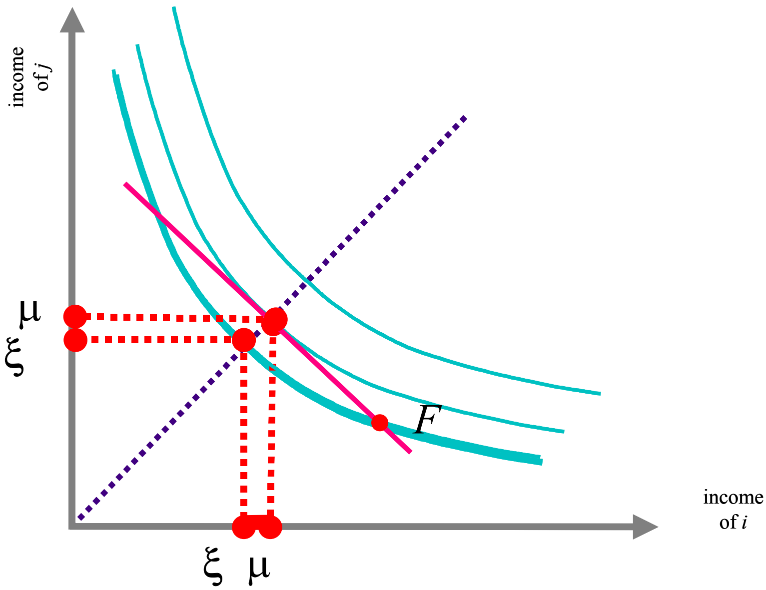


Figure 1: Relationship between equally-distributed income $\xi$ and mean $\mu$ for a distribution $F$: inequality aversion.

standard assumptions that are commonly made about the social-welfare function $W$?

By analogy with the risk counterpart it is easy to see the possible importance of anchoring within the context of social judgments. In this case we need some reference income that is pertinent in a social setting.

# 3 An Experimental Approach

In order to investigate the issues outlined in Section 2 we sought a methodology that presented the choice amongst income distributions within a context analogous to the experiments that had been applied in the preference reversals literature.

## 3.1 Experimental approaches in income distribution

Over the last decade a substantial literature has developed on questionnaire-experimental methods in the analysis of attitudes to income distribution. This focuses on the use of short questionnaires administered in a controlled setting and typically combining both numerical and verbal responses. The general approach is summarised in Amiel and Cowell (1999). The main thrust of this has been to investigate the degree of support for key axioms in the welfare-theoretic approach to income distribution. Some of this literature has attempted a combined or comparative approach to the related areas of risk and inequality – see Amiel and Cowell (2002), Amiel et al. (2001) and Kroll and Davidovitz (1999).

A fundamental difficulty in the context of income distribution concerns the involvement of the subject. In contrast to the experimental work referred to in section 1 the majority of questionnaire experimental studies place the respondent "outside" the setting on which he or she is invited to pass judgment; however there are some studies that have attempted to incorporate personal involvement – see e.g. Beckman et al. (1994)

## 3.2 The experimental design

We formulated our inequality questionnaires in a similar way to those that would have been presented in a risk context in the extensive preference-reversals literature. It seemed to us that a participatory experiment involving monetary rewards as outcomes was not the most appropriate way to model issues whether the primary focus is on social rankings and hypothetical social decisions.

Instead we designed a questionnaire experiment in which respondents were invited to imagine making a choice between distributions while acting as representatives for others. The nature of the choice is "distanced" from the individual by involving the hypothetical group of other people. The questionnaire is designed to reveal the way individuals would rank income distributions according to social criteria if the choice were presented to them in alternative formats. A combination of simple multiple choice and numerical questions were used – see the Appendix for examples of the types of questionnaires that were actually distributed. Versions in English, Hebrew and Spanish were provided for respondents in appropriate locations where the questionnaire was run.

**The Setting** We posit a group of countries – Alfaland, Betaland, Gammaland – that all have the same mythical currency the "Groat".[7] The reason for this slightly whimsical feature is as follows. To make the experiment operational we need to refer to some type of unit of account; both to make sensible comparisons of distributions and in order to express values that correspond to bids something (apparently) concrete must be specified. However, it is important that this unit of account does not have strong connotations with issues that lie outside the artificial experimental world: so a well-known currency unit drawn from contemporary experience is may not be appropriate. The groat (or its equivalent in other languages) has a certain "once-upon-a-time" air to it, although it is recognisable as a currency unit.

Because our questionnaires deal with income distributions, and because we want to consider a rather simple concept of income – that covers people's basic needs with perhaps a surplus – we considered only positive values for incomes.

Two of the countries have a simple income distributions characterised by the triple $(l, h, \theta)$ – a proportion $\theta$ of the population with low income $l$ and a proportion $1 - \theta$ with high income $h$. Alfaland is a higher inequality, higher income country than Betaland (mean income in Alfaland and Betaland is 37 groats and 26 groats respectively; Betaland Lorenz-dominates Alfaland) – clearly Alfaland is the counterpart of the $ bet and Betaland is the counterpart of the P bet. Gammaland is a perfectly equal country: everyone's income is $x$ groats, but $x$ is not specified. See figures 2 and 3 for a simple depiction.

[7] In the Hebrew translation this became the "Zuz" and in Spanish the "Vinten" – in each case a currency that has some echo of real value from the past, but does not carry any political baggage from the present-day world.

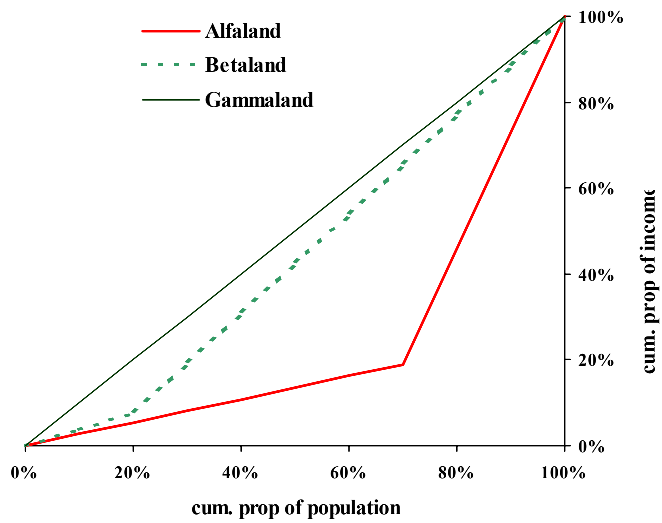


Figure 2: Alfaland, Betaland,Gammaland – Lorenz Curves

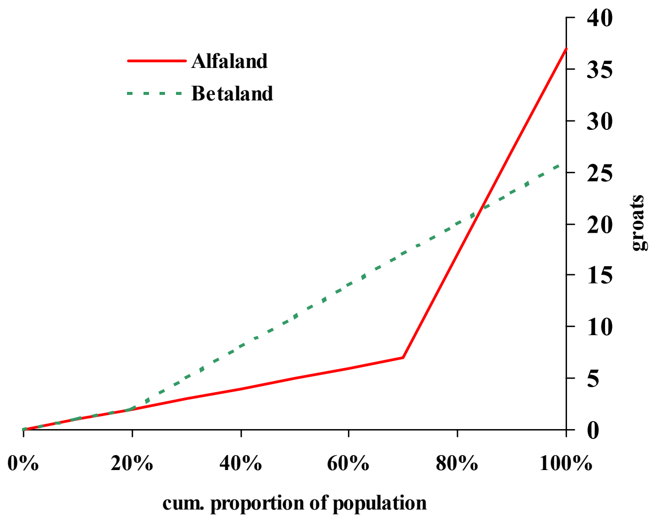


Figure 3: Alfaland and Betaland – Generalised Lorenz Curves

**The nature of choice** Since our questionnaires concern income distribution, respondents were asked about making social decisions: these decisions involve a whole group of people rather than just their own personal income or utility. Respondents were initially asked about Alfaland and Betaland in the following terms:

> "You are the leader of a small community that is considering a political union with one of the two countries. You expect that after the union the distribution of income in your small community will be the same as in the country you have joined."

In presenting the question in this way we put the person in the situation, but acting on behalf of others. The questionnaire leaves implicit that the respondent represents the interests of the community. However, the respondent is not invited to act as "big brother" because the context of the question automatically involves the person within the decision.

Furthermore the questionnaire is not directly about personal likes or dislikes. In order to capture the element of social choice amongst distributions (rather than personal preference amongst distributions) we deliberately avoided the language of personal valuation. Respondents were asked to consider the choices and then indicate what they would *decide* rather than what they would *prefer*.

**Uncertainty** A probability distribution was not explicitly described in the experiment – indeed the wording of the scenario made no reference to risk. However a probability distribution can be seen as implicit in the description of Alfaland and Betaland. The respondent was told "You are concerned about the community, rather than about yourself". There is no *personal* risk. The person is told that $\theta$ percent of *the group* will get $l$ groats and $1-\theta$ percent will get $h$ groats.

**Anchoring** As we have seen in section 1.2 the choice between distributions may be influenced by information concerning the value of the monetary units. We allowed for this by introducing an "anchor" in the form of a specified level of income that is considered to provide the basic needs for the inhabitants of any of the three countries. No further explanation was given about the nature of this basic needs income. It is not important for the present study whether people interpreted this as an absolute poverty line.

What is important is the perception of the distance of different groups in the income distribution for this reference point. To control for the importance of this distance our experiments used two different values of Basic-Needs Income (BNI): 5 groats and 10 groats.

**Two designs** We also experimented with two different versions of the design in order to check for the possible influence of the structure of the questions on the pattern of responses.

We went to the second design because of the order in which Alfaland and Betaland were presented. In the first version for question 2 (Alfaland) they could value it using a number higher than 30; so in question 3 (Betaland) they might have wanted to give a number higher than the previous one which might have appeared to them as inconsistent – if they believe in monotonicity.[8]

## 3.3 The sample

During 1999 – 2001 the experiment was run with a combined sample of 1239 respondents – see Table 1. In each case the experiment was run within class or lecture time and no preparation was given to the student respondents about either the theory of choice under uncertainty or the welfare economics of income distribution.

Roughly equal numbers were allocated to the two designs. Within each design both high BNI cases (10 groats) and low BNI cases (5 groats) were distributed. Respondents were not informed that fellow respondents might have been completing a questionnaire different from their own.

[8] As can be seen from the Appendix there were also other presentational differences between the two designs – for example the depiction of Alfaland and Betaland by boxes in design 2.

| Design 1 | | Design 2 | |
|---|---|---|---|
| Haifa | 71 | Ruppin | 263 |
| Bar-Ilan | 35 | Bonn | 189 |
| Fiji | 224 | E.Carolina | 87 |
| Ruppin | 179 | LSE | 79 |
| Cornell | 12 | | |
| Uruguay | 100 | | |
| | *621* | | *618* |

Table 1: The Sample

### 3.4 Interpreting the responses

**The choice question** First we check those responses that give categorical answers rather than a single real-number value. The summary of the responses to question 1 are given on the left-hand side of Tables 2 and 3.

This reveals information about tastes for redistribution and is not the central focus of our study. However it is clear that in both designs the B-responses ("choose Betaland") dominate.[9] The difference between the designs in terms of the I-response ("toss a coin to decide") is readily explained once we look at the response breakdown by participating institution in Tables 4 and 5.[10] It is clear that for some reason Israeli respondents are overwhelmingly decisive in favour of A or B –few chose the option of indifference between Alfaland and Betaland and the fraction choosing A is quite similar to the fraction choosing B (contrary to Uruguay).

**The valuation questions** More interesting is the use of the choice question in relation to the numerical answers on questions 2 and 3. The responses to the numerical questions correspond, in

[9]Note that the P bet was chosen more frequently also in previous work on preference reversals reported in the risk literature.

[10]Here we have also broken the Ruppin subsample into two: *Ru. Ec* in Tables 4 and 5 means just the regular economics students; *Ru. EBA* means "Ruppin, Executive Business Administration" and forms a qualitatively different group from those of the economics students – they are older and have more experience in management.

effect, to an implied "bid" for the egalitarian income distribution in Gammaland

First, note that if people's rankings over income distributions conform to the axioms of underlying second-order distributional dominance then this imposes bounds on the possible values of income to be assigned to perfectly egalitarian Gammaland – see figure 4. Second one may similarly apply bounds that indicate consistency with first-order dominance.

### 3.4.1 Distributional dominance

In the light of this it is of interest to check those responses where $x < l$ or $x > h$ for both $x_2$ and $x_3$ where $l$ and $h$ are the two given income levels described on page 9; this is given by the numerical answers to questions 2 and 3 respectively. A summary given in the right-hand half of Table 2 (Design 1) and of Table 3 (Design 2): remember that (a) the value of $l$ is the same for both questions, (b) the value of $h$ differs between the questions and (c) that the $h$-values for questions 2 and 3 are interchanged between the two experimental designs. Note that if there are such violations it does not imply that a person is inconsistent or illogical. The person's views may simply not conform to the principle of monotonicity that is often – but not always – applied in the welfare-economics literature.[11] Figure 5 illustrates indifference curves representing preferences for the two types of violation.

It is possible that respondents may be influenced by the structure of the questionnaire and that this has contributed significantly to the violations of monotonicity: for this reason we tried two different designs – see the discussion in section 3.2. However it is clear that the violations of monotonicity are not just an artefact of an ordering effect in design 1: it persists in design 2.

[11] Violations of monotonicity are of course also well-known in the experimental literature on welfare economics – see, for example, Amiel and Cowell (1999, pp. 64-66,119-120) and McClelland and Rohrbaugh (1978) in the context of the Pareto principle.

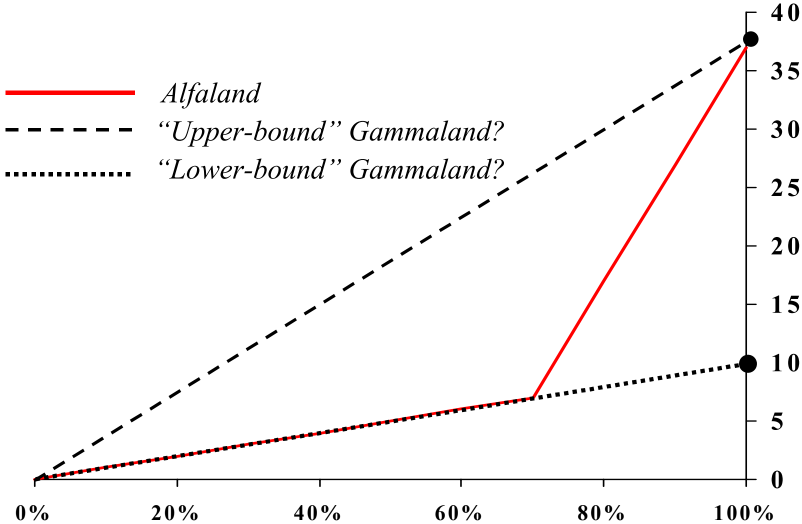


Figure 4: Second-order dominance bounds

| *Q1* | | | | *Q2* | | *Q3* | |
|---|---|---|---|---|---|---|---|
| | | | | Alfaland | | Betaland | |
| A | 157 | 25.3% | $x < l$ | 34 | 5.5% | 28 | 4.5% |
| I | 38 | 6.1% | $x = l$ | 59 | 9.5% | 47 | 7.6% |
| B | 403 | 64.9% | $l < x < h$ | 482 | 77.6% | 252 | 40.6% |
| *NA** | 23 | 3.7% | $x = h$ | 19 | 3.1% | 96 | 15.5% |
| | *621* | | $x > h$ | 14 | 2.3% | 180 | 29.0% |
| | | | *NA** | 13 | 2.1% | 18 | 2.9% |
| | | | | *621* | | *621* | |

*NA means blank or other response

Table 2: Distribution of Responses: design 1

| | *Q1* | | | *Q2* Betaland | | *Q3* Alfaland | |
|---|---|---|---|---|---|---|---|
| A | 131 | 21.2% | $x < l$ | 17 | 2.8% | 15 | 2.4% |
| I | 152 | 24.6% | $x = l$ | 21 | 3.4% | 24 | 3.9% |
| B | 331 | 53.6% | $l < x < h$ | 358 | 57.9% | 510 | 82.5% |
| *NA** | 4 | 0.6% | $x = h$ | 92 | 14.9% | 22 | 3.6% |
| | *618* | | $x > h$ | 118 | 19.1% | 27 | 4.4% |
| | | | *NA* | 12 | 1.9% | 20 | 3.2% |
| | | | | *618* | | *618* | |

*NA means blank or other response

Table 3: Distribution of Responses: design 2

| | *Ru. Ec.* | *Ru. EBA* | *Haifa* | *Bar-Ilan* | *Fiji* | *Cornell* | *Uruguay* |
|---|---|---|---|---|---|---|---|
| A | 42.2% | 27.3% | 39.6% | 65.7% | 20.1% | 0.0% | 10.0% |
| I | 2.0% | 5.2% | 2.8% | 0.0% | 57.1% | 0.0% | 3.0% |
| B | 55.9% | 67.5% | 57.5% | 34.3% | 21.4% | 100.0% | 86.0% |
| *NA* | *0.0%* | *0.0%* | *0.0%* | *0.0%* | *1.3%* | *0.0%* | *1.0%* |

Table 4: Responses by institution: design 1

| | *Ruppin* | *Bonn* | *E.Carolina* | *LSE* |
|---|---|---|---|---|
| A | 45.2% | 2.1% | 8.0% | 1.3% |
| I | 4.9% | 52.4% | 19.5% | 27.8% |
| B | 49.0% | 45.0% | 70.1% | 70.9% |
| *NA* | *0.8%* | *0.5%* | *2.3%* | *0.0%* |

Table 5: Responses by institution: design 2

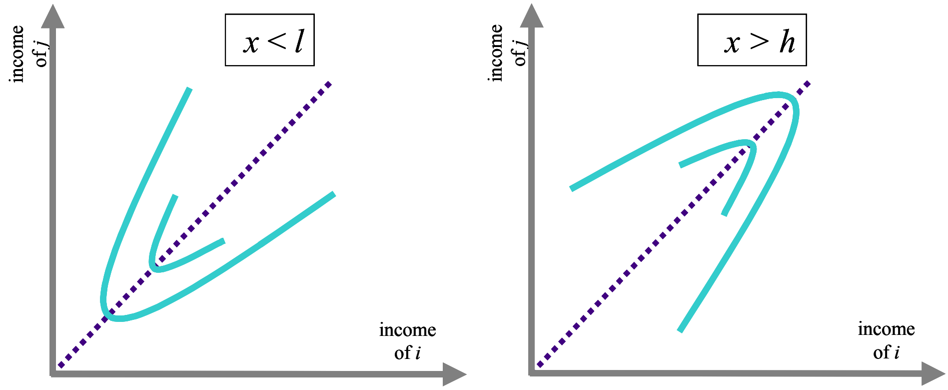


Figure 5: Violations of monotonicity

### 3.4.2 Preference reversals

The issue of preference reversals can be handled separately from the question of consistency with dominance principles. The procedure is to identify those who answered $A$ and who gave usable responses on both Q2 and Q3 and then to partition them into the separate cases $x_3 > x_2$, $x_3 = x_2$, $x_3 < x_2$ ; one then repeats this for the $B$ and $I$ responses on question 1. It is appropriate to distinguish between Strong Reversals and Weak Reversals.

Strong reversals are those where the pair of responses to questions 2 and 3 flatly contradict the choice indicated in the response to question 1. In Design 1 this means responses where the person indicated A on question 1 but then gave numerical values such that $x_3 > x_2$, or the person indicated B on question 1 and then stated numerical values $x_3 < x_2$. In Design 2 strong PR corresponds to the reverse pattern.[12]

Weak preference reversals are made up of two types:

1. Where a strict preference for Alfaland or Betaland was expressed in question 1 but equal amounts were stated in questions 2 and 3.

[12] I.e. responses where the person indicated A on question 1 but then gave numerical values such that $x_3 < x_2$, or the person indicated B on question 1 and then stated numerical values $x_3 > x_2$.

2. Where indifference was expressed in question 1 but different amounts were stated in questions 2 and 3.

# 4 Preference Reversals: Results

The overall results by experimental design and gender of respondent are given in Table 6. The rows are arranged, first according to the possible responses on the straightforward choice question (question 1) and then by the category of response when taking into account the responses to questions 2 and 3. We classify these by abbreviations as follows: SPR (strong preference reversal),[13] WPR (weak preference reversal), NPR (no preference reversal); the two SPR cases are highlighted in bold. It is clear that although the proportion of A-type SPR responses (where the person chose Alfaland on Q1) is small, the proportion of B-type SPR responses (where the person chose Betaland on Q1) is substantial on either design and for both gender groups. The gender issue is of interest because in other experimental contexts there is a marked difference between male and female respondents in terms of their support for the transfer principle (Amiel and Cowell 2002). A simple $\chi^2$-test shows that this difference in responses between males and females is significant at the 5% level.

For some subgroups of the sample the low proportion of A-type SPR responses is obviously attributable to respondents having inequality preferences such that very few chose Alfaland rather than Betaland in question 1. But, as we have noted, this preference pattern does not apply to the Israeli subgroups (Tables 4 and 5). So it is interesting to note that even here the A-type SPR response is low.[14]

By contrast the substantial showing of B-type SPR responses is remarkable and in line with results from the literature on preference reversals in the risk context (the case of the "P bet").

[13]Remember that where SPR is implied by $x_3 > x_2$ in design 1 it is given by the opposite condition, $x_3 < x_2$ in design 2: see subsection 3.4.2 above.

[14]In the case of design 1 the proportions of these responses are:2% for Ruppin Economics, 6.5% for Ruppin EBA, 10.4% for Haifa, 8.6% for Bar Ilan; in the case of design 2: 6.5% for Ruppin.

| *Q1* | | *Q2,Q3* | **Design 1** *All* | *Males* | *Females* | *Q2,Q3* | **Design 2** *All* | *Males* | *Females* |
|---|---|---|---|---|---|---|---|---|---|
| **A** | **SPR** | **x2<x3** | **4.7%** | **4.0%** | **5.5%** | **x2>x3** | **2.8%** | **3.0%** | **2.7%** |
| A | WPR | x2=x3 | 4.2% | 4.7% | 3.7% | x2=x3 | 2.6% | 3.0% | 1.8% |
| A | NPR | x2>x3 | 16.4% | 17.4% | 14.9% | x2<x3 | 15.0% | 16.7% | 14.0% |
| I | WPR | x2<x3 | 2.6% | 2.4% | 2.7% | x2<x3 | 20.2% | 24.7% | 13.6% |
| I | WPR | x2>x3 | 1.9% | 1.2% | 2.7% | x2>x3 | 2.1% | 2.4% | 1.4% |
| I | NPR | x2=x3 | 1.6% | 1.6% | 1.8% | x2=x3 | 1.5% | 2.2% | 0.5% |
| **B** | **SPR** | **x2>x3** | **26.9%** | **32.4%** | **22.9%** | **x2<x3** | **26.7%** | **21.5%** | **34.4%** |
| B | WPR | x2=x3 | 13.7% | 10.7% | 16.2% | x2=x3 | 8.7% | 9.1% | 8.1% |
| B | NPR | x2<x3 | 24.3% | 24.9% | 24.7% | x2>x3 | 16.5% | 14.8% | 18.1% |
| *(NA)* | | | *3.7%* | *0.8%* | *4.9%* | | *3.9%* | *2.7%* | *5.4%* |
| | | *N=* | *621* | *253* | *328* | *N=* | *618* | *372* | *221* |

Table 6: Responses by gender and design

| *Q1* | | *Q2,Q3* | **Design1** *All* | *C5* | *C10* | *Q2,Q3* | **Design 2** *All* | *C5* | *C10* |
|---|---|---|---|---|---|---|---|---|---|
| **A** | **SPR** | **x2<x3** | **4.7%** | **5.3%** | **3.8%** | **x2>x3** | **2.8%** | **3.2%** | **2.3%** |
| A | WPR | x2=x3 | 4.2% | 5.9% | 1.9% | x2=x3 | 2.6% | 1.6% | 3.6% |
| A | NPR | x2>x3 | 16.4% | 18.2% | 14.1% | x2<x3 | 15.0% | 18.1% | 12.0% |
| I | WPR | x2<x3 | 2.6% | 3.6% | 1.1% | x2<x3 | 20.2% | 24.3% | 16.2% |
| I | WPR | x2>x3 | 1.9% | 2.5% | 1.1% | x2>x3 | 2.1% | 1.9% | 2.3% |
| I | NPR | x2=x3 | 1.6% | 1.7% | 1.5% | x2=x3 | 1.5% | 1.6% | 1.3% |
| **B** | **SPR** | **x2>x3** | **26.9%** | **23.5%** | **31.6%** | **x2>x3** | **26.7%** | **23.6%** | **29.8%** |
| B | WPR | x2=x3 | 13.7% | 12.0% | 16.0% | x2=x3 | 8.7% | 7.4% | 10.0% |
| B | NPR | x2<x3 | 24.3% | 22.6% | 26.6% | x2<x3 | 16.5% | 12.6% | 20.4% |
| *(NA)* | | | *3.7%* | *4.7%* | *2.3%* | | *3.9%* | *5.5%* | *2.3%* |
| | | *N=* | *621* | *358* | *263* | *N=* | *618* | *309* | *309* |

Table 7: Responses by BNI and design

## 4.1 The "anchor"

As the discussion of the independence axiom noted (section 1.2) the role of anchoring has been argued as a possible explanatory factor for the preference-reversal phenomenon. In our case we used the Basic Needs Income (BNI) as an anchor, in one case placing BNI at the lower point of the simple income distribution. Table 7 reports the results for the two levels of BNI (labelled C5 and C10 respectively), and compare how these two levels affect the decisions made by respondents. It is clear that the proportion of Betaland-response SPR is slightly higher when the BNI level is high (10 groats rather than 5 groats): again a $\chi^2$-test shows that this difference is significant at the 5% level.

## 4.2 Conditional probabilities

Given that people's preferences may differ according to personal attributes – gender, country of origin and so on – it is interesting to see what the probability of a preference-reversal response is conditional on a particular type of response to question 1 that elicits information about distributional preferences.

**The overall picture** The summary results on these conditional probabilities are presented in Tables 8 and 9. Again we see that the welfare comparison experiment confirms the standard outcomes from the preference-reversal literature: the probability of a strong preference reversal conditional on selecting Betaland in the first question (the counterpart to the P-bet) is much higher than the probability conditioned on selecting Alfaland. This result holds for both sample designs. However it does not hold for weak preference reversals separately – here the conditional probabilities are about the same for both types of question 1 responses.

**Breakdown by University** It is also clear that, with one exception (the Ruppin Executive Business Administration students), the pattern of conditional probabilities is manifest across the different subsamples – see Tables 10 and 11. We can reasonably

| | Whole Sample | "poverty line" subsample | |
|---|---|---|---|
| | | 5 groats | 10 groats |
| **Of those who chose Alfaland** | | | |
| SPR | 18.5% | 18.1% | 19.2% |
| WPR | 16.6% | 20% | 9.6% |
| **Of those who chose Betaland** | | | |
| SPR | 41.4% | 40.4% | 42.6% |
| WPR | 21.1% | 20.7% | 21.5% |

Table 8: Conditional probabilities of preference reversals: Design 1

| | Whole Sample | "poverty line" subsample | |
|---|---|---|---|
| | | 5 groats | 10 groats |
| **Of those who chose Alfaland** | | | |
| SPR | 13.5% | 14.1% | 12.7% |
| WPR | 12.7% | 7.0% | 20.0% |
| **Of those who chose Betaland** | | | |
| SPR | 51.4% | 54.1% | 49.5% |
| WPR | 16.8% | 17.0% | 16.7% |

Table 9: Conditional probabilities of preference reversals: Design 2

| | *Ru. Ec.* | *Ru. EBA* | *Haifa* | *Bar-Ilan* | *Fiji* | *Cornell* | *Uruguay* |
|---|---|---|---|---|---|---|---|
| | | | | **Of those who chose Alfaland** | | | |
| SPR | 4.7% | 23.8% | 27.5% | 13.6% | 25.6% | | 0.0% |
| WPR | 0.0% | 23.8% | 5.0% | 4.5% | 32.6% | | 50.0% |
| | | | | **Of those who chose Betaland** | | | |
| SPR | 80.7% | 9.6% | 43.1% | 33.3% | 41.8% | 33.3% | 33.7% |
| WPR | 7.0% | 36.5% | 15.5% | 41.7% | 23.4% | 8.3% | 22.9% |

Table 10: Conditional probability of preference reversal (Design 1)

| | *Ruppin* | *Bonn* | *E.Carolina* | *LSE* |
|---|---|---|---|---|
| | | **Of those who chose Alfaland** | | |
| SPR | 13.0% | 0.0% | 28.6% | 0.0% |
| WPR | 11.3% | 33.3% | 14.3% | 100.0% |
| | | **Of those who chose Betaland** | | |
| SPR | 52.8% | 60.5% | 47.5% | 38.9% |
| WPR | 18.4% | 7.4% | 23.0% | 20.4% |

Table 11: Conditional probability of preference reversal (Design 2)

conclude that the distinctive B-type versus A-type contrast in the conditional probabilities is not an artefact of the differing views about the inequality-mean income trade-off that are displayed by different sample subgroups.

### 4.3 Regression Analysis

In order to investigate the determinants of preference reversal behaviour consider a simple regression model using the personal characteristics and information about sample characteristics.

The appropriate specification is an ordered probit: the dependent variable takes the value 0 for no preference reversal, 1 for weak preference reversal and 2 for strong preference reversal. The principal regressions are reported in Tables 12–14.

Table 12 gives the estimates for the whole sample; the four columns correspond to the four main equation specifications and the entries in small type are robust standard errors. Variables included in each specification are as follows:

1. Personal characteristics (`age` in years; `female`, a dummy) , questionnaire-design features including design type ( `d1`, a dummy) and level of BNI (`c5`, a dummy) and choices on question 1 ( `A` and `B` are dummies)[15]

2. As in 1 but also country indicator of subsample.[16]

3. As in 1 but also institution indicator of subsample.[17]

4. As in 2 but also subject studied.[18]

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[15] The case "indifferent" is the omitted variable.

[16] Dummies for `uruguay`, `israel`, `germany`, `us`, `fiji`; UK is the omitted case.

[17] Dummies for `uruguay`, `fiji`, `ruppin` (Ruppin Institute), `bar` (Bar-Ilan), `haifa`, `bonn`, `eastc` (East Carolina), `cornell`; LSE is the omitted case.

[18] Dummies for `econ`, `biz` (business studies), `socpol` (social policy), `eng` (engineering), `math`.

| | Spec 1 | Spec 2 | Spec 3 | Spec 4 |
|---|---|---|---|---|
| age | -0.005 | -0.004 | -0.003 | -0.005 |
| | 0.007 | 0.007 | 0.007 | 0.007 |
| female | 0.019 | 0.014 | 0.0001 | 0.029 |
| | 0.102 | 0.101 | 0.100 | 0.098 |
| c5 | -0.002 | -0.025 | -0.028 | -0.042 |
| | 0.068 | 0.070 | 0.070 | 0.066 |
| d1 | -0.098 | -0.098 | -0.075 | -0.065 |
| | 0.091 | 0.131 | 0.215 | 0.141 |
| A | -0.611** | -0.569** | -0.548** | -0.553** |
| | 0.215 | 0.260 | 0.263 | 0.263 |
| B | 0.312*** | 0.364*** | 0.376*** | 0.393*** |
| | 0.072 | 0.064 | 0.062 | 0.058 |
| uruguay | | -0.125 | -0.160 | 0.043 |
| | | 0.214 | 0.265 | 0.144 |
| israel | | 0.082 | | 0.073 |
| | | 0.151 | | 0.102 |
| germany | | 0.19* | | 0.236** |
| | | 0.111 | | 0.114 |
| us | | 0.070 | | -0.070 |
| | | 0.132 | | 0.154 |
| fiji | | 0.207 | 0.178 | 0.161 |
| | | 0.173 | 0.230 | 0.155 |

...continued

It is clear that in each of these specifications the overwhelmingly important determinant of preference reversals is the set of personal values that determine the choice on question 1. Curiously studying mathematics predisposes people towards preference reversals while studying social policy or engineering[19] predisposes them in the opposite direction.

To get some further insight on the determinants of preference reversals examine the estimates for the two subsamples responding “A” and “B” in question 1 – see Tables 13 and 14 respectively.

[19] Mathematics students were from University of South Pacific, Fiji; Social policy students were from LSE; engineering students were from Uruguay.

...continued

| | Spec 1 | Spec 2 | Spec 3 | Spec 4 |
|---|---|---|---|---|
| ruppin | | | 0.037 | |
| | | | 0.157 | |
| bar | | | -0.126 | |
| | | | 0.199 | |
| haifa | | | 0.205 | |
| | | | 0.209 | |
| bonn | | | 0.188* | |
| | | | 0.113 | |
| eastc | | | 0.131 | |
| | | | 0.112 | |
| cornell | | | -0.430* | |
| | | | 0.247 | |
| econ | | | | 0.052 |
| | | | | 0.166 |
| biz | | | | 0.337 |
| | | | | 0.228 |
| socpol | | | | -0.481*** |
| | | | | 0.144 |
| eng | | | | -0.406*** |
| | | | | 0.150 |
| math | | | | 0.536*** |
| | | | | 0.164 |

Robust standard errors adjusted for clustering on universities

* significant at 10% level; ** significant at 5%;, *** significant at 1%

Table 12: Ordered Probit - All observations, N=1190

| | | | | |
|---|---|---|---|---|
| age | 0.010 | 0.020 | -0.009 | -0.004 |
| | 0.015 | 0.017 | 0.007 | 0.008 |
| female | 0.114 | 0.081 | 0.008 | -0.001 |
| | 0.116 | 0.100 | 0.134 | 0.128 |
| c5 | -0.112 | -0.130 | -0.054 | -0.189 |
| | 0.189 | 0.179 | 0.231 | 0.165 |
| d1 | 0.072 | -0.227 | 0.076 | -0.386 |
| | 0.349 | 0.384 | 0.302 | 0.271 |
| uruguay | -0.633 | -0.323 | | 0.513 |
| | 0.411 | 0.437 | | 0.545 |
| israel | -0.967*** | | | 0.136 |
| | 0.169 | | | 0.438 |
| germany | -0.601*** | | | -0.608 |
| | 0.082 | | | 0.435 |
| us | -0.368*** | | | |
| | 0.088 | | | |
| fiji | -0.208 | 0.116 | | 1.126** |
| | 0.340 | 0.361 | | 0.514 |
| ruppin | | -1.014*** | | |
| | | 0.185 | | |
| bar | | -0.868** | | |
| | | 0.371 | | |
| haifa | | 0.222 | | |
| | | 0.353 | | |
| bonn | | -0.599*** | | |
| | | 0.077 | | |
| eastc | | -0.310*** | | |
| | | 0.068 | | |
| econ | | | -0.639** | -1.003*** |
| | | | 0.287 | 0.326 |
| biz | | | -0.267 | -0.486 |
| | | | 0.278 | 0.442 |
| eng | | | -0.109 | -0.336 |
| | | | 0.261 | 0.402 |
| math | | | 1.312*** | 0.666 |
| | | | 0.337 | 0.490 |

Robust standard errors adjusted for clustering on universities

* significant at 10% level; ** significant at 5%;, *** significant at 1%

Table 13: Ordered Probit - Those responding A: N=283

| | | | | |
|---|---|---|---|---|
| age | -0.009 | -0.011 | -0.004 | -0.007 |
| | 0.014 | 0.016 | 0.011 | 0.012 |
| female | -0.010 | -0.006 | 0.043 | 0.069 |
| | 0.158 | 0.157 | 0.154 | 0.157 |
| c5 | -0.013 | -0.016 | -0.053 | -0.016 |
| | 0.097 | 0.096 | 0.094 | 0.100 |
| d1 | -0.198 | -0.056 | -0.176 | 0.023 |
| | 0.304 | 0.501 | 0.153 | 0.299 |
| uruguay | 0.083 | -0.048 | | 0.225 |
| | 0.374 | 0.541 | | 0.307 |
| israel | 0.346*** | | | 0.246 |
| | 0.129 | | | 0.183 |
| germany | 0.317*** | | | 0.672** |
| | 0.096 | | | 0.272 |
| us | 0.121 | | | 0.055 |
| | 0.121 | | | 0.247 |
| fiji | 0.257 | 0.119 | | -0.086 |
| | 0.337 | 0.517 | | 0.362 |
| ruppin | | 0.339** | | |
| | | 0.133 | | |
| bar | | 0.121 | | |
| | | 0.516 | | |
| haifa | | 0.032 | | |
| | | 0.499 | | |
| bonn | | 0.320*** | | |
| | | 0.096 | | |
| eastc | | 0.165* | | |
| | | 0.099 | | |
| cornell | | -0.257 | | |
| | | 0.514 | | |
| econ | | | 0.260* | 0.482* |
| | | | 0.151 | 0.275 |
| biz | | | 0.252 | 0.646 |
| | | | 0.215 | 0.418 |
| socpol | | | -0.531*** | -0.078 |
| | | | 0.177 | 0.282 |
| eng | | | -0.379** | -0.358** |
| | | | 0.150 | 0.177 |
| math | | | 0.520* | 0.917*** |
| | | | 0.266 | 0.329 |



Table 14: Ordered Probit - Those responding B: N=723

Clearly some country variables (and the corresponding institution indicators are now important) – for example the B-preferring respondents from Israel and Germany subsamples are predisposed towards preference reversals while the A-preferring respondents are predisposed in the opposite direction; similar remarks apply to the US. Economists in the A-responding subgroup are less predisposed to preference reversals.[20]

Some might argue that to include all observations in the estimation – including those who violated monotonicity by "pricing" Gammaland above $h$ or below $l$ – is inappropriate. We reran the equations reported in Tables 12–14 on a restricted sample that excluded all responses where $x < l$ or $x > h$ on question 2 or 3. The results from these regressions show little difference from those on the full sample: the coefficient on age is now significant and negative for the full sample and for the A-subsample – as people get older they tend to be less prone to preference reversal.

Two effects are remarkable by their absence from any of their regressions – either on the full sample or the A-responding or B-responding subsamples, or from the restricted subsamples. Nowhere does the design of the questionnaire (captured by the `d1` dummy) or BNI (captured by the `c5` dummy) have an effect on the probability of exhibiting a preference reversals. There is no evidence of a framing effect in this context.

# 5 Discussion

Why does one get preference reversals in the income-distribution context? In this section we provide some remarks to compare the phenomena reported here with what is known from the literature explaining preference reversals in the risk context, as discussed in section 1.

1. *Income and endowment effects.* These are not relevant to the present case. Throughout each version of the questionnaire experiment there is the same notional starting point.

[20] Some dummies have been dropped because of problems of multicollinearity – this accounts for the absence of `cornell` and `socpol` from Table 13

2. *Intransitive preferences.* Given the simple structure of our questionnaire it is unclear that this has a role to play in the present case (Fishburn 1985). Furthermore, although Regret Theory allows for intransitivity of preferences, it does not appear to be relevant to our problem.

3. *Framing Effect.* In order to control for this we used two different versions in our questionnaire. However the data reveal no evidence of such a framing effect.

4. *Complexity.* It is known from the conventional preference-reversal literature that when the probabilities of the lotteries involved are displayed in a less comprehensible format for the subjects, this causes an underpricing of the P-bet (Johnson et al. 1988, Seidl 2002). This appears to be relevant in the case of the Gammaland-Betaland case in our experiments too.

5. *Anchoring.* As noted in section 1.2 the anchoring phenomenon might cause violation of the independence axiom. The basic needs income level serves as an anchor in our income distribution problem. But it is clear from our control for the two levels of BNI that this effect does not play a significant role in the pattern of responses.

6. *Overpricing.* Violation of first-order dominance could have been just an ordering effect in design 1, but it persists in design 2. In the risk context such violations mean that the amount they want to pay for a gamble with a maximum payoff of $x$ is greater than or equal to $x$: sometimes overpricing the $ bet causes subjects to put a price higher than the maximum in the alternative. Since the subjects' answer is in monetary terms, they respond more readily to the $ bet than to the P bet. This appears to be relevant as an explanation in our case too – particularly in the case of Israeli respondents who chose Alfaland. We may have the welfare-economic counterpart of the failure of procedure invariance discussed by Tversky et al. (1990).

# 6 Conclusion

The parallels between PR in their "natural habitat" of individual risk preference and in the welfare-theoretic analysis of income distribution are striking. We might go further and say that we could have expected PR to be less of a problem in the present context than in the case of risk. The statement "70% of the people have an income of 10 Groats, the remaining 30% get 100 Groats" may seems to be less abstract than the statement "There is a probability of 0.7 that you will get 10 Groats and a probability of 0.3 that you will get 100 Groats". People can have difficulty in understanding what probabilities are, but we may hope that they know well enough what a fraction is. Of course probabilities can be translated into fractions, but this involves a counterfactual and is thus rather a difficult exercise. This makes the presence of PR in the social-welfare and income distribution context rather remarkable.

Preference reversals appear as a kind of "dysfunction" in the theory of choice under uncertainty. The same could be said about our application to social choice amongst income distributions too. However it is a dysfunction that has potentially profound implications in two areas.

First, it affects thinking about economic policy toward income distribution. An attempt to deduce the public's willingness to trade off, say, overall income for greater equality is likely to be dramatically affected by the way in which the notional choice is presented.

Second there are further implications for the formal analysis of social welfare. As in previous studies we have found evidence of violations monotonicity that, in turn, implies violations of dominance criteria. However, there is something more. If preference reversals are important then the concept of a well-defined, unique equally-distributed equivalent income may no longer be valid.

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# A Questionnaires

Following are the two designs of the questionnaire used in the experiments reported in the main text.

**Design 1**

# Income Distribution Questionnaire

1. The percapita income of 70% of the citizens of Alphaland is 10 Groats, and the per capita income of the remaining 30% is 100 Groats. In Betaland 20% of the citizens have a percapita income of 10 Groats, while the other 80% have a percapita income of 30 Groats. In each country the income that secures a supply of basic needs is 5 Groats. You are the leader of a small community that is considering a political union with one of the two countries. You expect that after the union the distribution of income in your small community will be the same as in the country you have joined. What would you decide? Please check (✔) one…

| | | | | | |
|---|---|---|---|---|---|
| ***Definitely join Alfaland*** | ☐ | ***Definitely join Betaland*** | ☐ | ***Toss a coin to decide…*** | ☐ |

2. As before the percapita income of 70% of the citizens of Alphaland is 10 Groats, and the percapita income of the remaining 30% is 100 Groats. In Gammaland all citizens have equal per capita income. In each country the basic-needs income level is 5 Groats. In your opinion, what is the minimum percapita income in Gammaland to ensure that the population would be better off in Gammaland than in Alphaland?

   _________ ***Groats***

3. Assume that all the data in questions 1 and 2 remain unchanged. In your opinion, what is the minimum percapita income in Gammaland to ensure that the population would be better off in Gammaland than in Betaland?

   _________ ***Groats***

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*Finally, we would be grateful for some information about yourself:*

- Are you male or female? M/F
- What is your age? _____ years
- What is your special subject? __________
- In which year are you? __________

**Design 2**

# Income Distribution Questionnaire

1. The percapita income of 70% of the citizens of Alfaland is 10 Groats, and the percapita income of the remaining 30% is 100 Groats. In Betaland 20% of the citizens have a percapita income of 10 Groats, while the other 80% have a percapita income of 30 Groats. In each country the income that secures a supply of basic needs is 5 Groats (see table below). You are the leader of a small community that is considering a political union with one of the two countries. You expect that after the union the distribution of income in your small community will be the same as in the country you have joined. What would you decide? Please check (✔) one…

| **Definitely join Alfaland** ☐ | **Definitely join Betaland** ☐ | **Toss a coin to decide…** ☐ |
|---|---|---|

| **Alfaland** | | **Betaland** | |
|---|---|---|---|
| 70% | 10 Groats | 20% | 10 Groats |
| 30% | 100 Groats | 80% | 30 Groats |
| *needs level =* | *5 Groats* | *needs level =* | *5 Groats* |

2. In Gammaland all citizens have the same per capita income and again the basic-needs income level is 5 Groats. In your opinion, what is the minimum percapita income in Gammaland that would persuade you to move to Gammaland rather than Betaland? (See the income distribution for Betaland in the box above)

**_________ Groats**

3. In your opinion, what is the minimum percapita income in Gammaland that would persuade you to move to Gammaland rather than Alfaland? (See the income distribution for Alfaland in the box above)

**_________ Groats**

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*Finally, we would be grateful for some information about yourself:*

- Are you male or female? M/F
- What is your age? _____ years
- What is your special subject? ___________
- In which year are you? ___________