Social Welfare, the Veil of Ignorance and Purely Individual Risk: An Empirical Examination

Kristof Bosmans and Erik Schokkaert*

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Abstract

We present the results of a questionnaire study with Belgian undergraduate students as respondents. We consider the relationship between people's direct ethical preferences, their preferences behind a veil of ignorance, and their purely individual risk preferences over income distributions. The results reveal that, although there are important similarities between the three types of preferences, the first and third types form two extremes, while the second type lies in between the other two. Consistency of response patterns with the expected utility (EU) and rank-dependent expected utility (RDEU) models—natural analogues of the social welfare functions most frequently used in the literature on inequality and social welfare—is tested as well. For all three types of preferences the results reveal that, in the considered context, the RDEU model does not add explanatory power to the EU model. However, preferences appear to be relatively well described by some of the basic concepts from non-expected utility theory not usually considered in the income distribution literature.

*Centre for Economic Studies, K.U.Leuven, Naamsestraat 69, B-3000 Leuven, Belgium. E-mail: kristof.bosmans@econ.kuleuven.ac.be and erik.schokkaert@econ.kuleuven.ac.be.
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1 Introduction

The central problem of distributive justice is finding an ethical ranking of income distributions. It is generally accepted that such an ethical ranking should reflect in a certain sense the preferences of an impartial and sympathetic observer (henceforth referred to as "ISO preferences")—"... a person taking a positive sympathetic interest in the welfare of *each* participant but having no partial bias in favor of *any* participant" (Harsanyi, 1977, p. 49). ISO preferences have been analysed in the literature in many different ways, but a particularly influential approach has been the exploration of the formal links between inequality and risk (Cowell and Schokkaert, 2001). This link has been put forward in its most explicit form in Harsanyi's (1953, 1955) approach of the veil of ignorance.[1]

Harsanyi rephrases the problem of distributive justice as a problem of individual decision making under risk: income distributions should be ranked according to the preferences of a rational individual behind the veil of ignorance (henceforth, "VOI preferences"). VOI preferences are the preferences over income distributions of a rational individual who does not know her own position in each income distribution (nor the position of the other members of society) and has (like these other members), for each income distribution, an equal probability of ending up with the income of any of the members of society. Harsanyi argues that rationality requires that VOI preferences be consistent with expected utility (EU) theory. By consequence, the social welfare function, which represents ethical preferences, inherits the formal properties of the EU model and is of the mean utilitarian type.[2] This approach is often seen as providing a justification for the most frequently used social welfare function in the income distribution literature, which is of the mean utilitarian form with utility a function exclusively of own income and an identical utility function for each individual.[3] However, this approach raises two sets of questions.

First, it is not obvious that VOI preferences and ISO preferences indeed coincide. The idea of the veil of ignorance is only one among many proposed approaches to the problem of finding an ethical ranking of income distribu-

[1]Similar approaches have been proposed by Vickrey (1945, 1960) and Rawls (1958, 1971). The latter coined the term "veil of ignorance." Harsanyi used the approach to justify (mean) utilitarianism while Rawls used it to justify his deontological theory which couples a respect for basic liberties with maximin in "primary goods."

[2]Harsanyi's claim that mean utilitarianism follows from his assumptions has been criticized on several accounts. See Mongin (2001) for a thorough overview of the literature.

[3]See Cowell (2000) and Lambert (2001) for recent overviews of this literature.

tions. Moreover, the assumption that utility is a function exclusively of own income does not follow directly from Harsanyi's conditions. Indeed, VOI preferences are preferences over lotteries that have complete income distributions as outcomes, not preferences over lotteries with individual incomes as outcomes. We refer to the latter type of preferences as purely individual risk preferences (henceforth, "PIR preferences"). The assumption that utility is a function exclusively of own income can be justified if VOI preferences are identical to PIR preferences. Differences between VOI preferences and PIR preferences can result from the fact that the individuals do not care only about their own incomes, but also for instance about overall equality or about their own relative income position. A comparison of ISO and VOI preferences with PIR preferences therefore could give some insight into the importance of externalities. What is the exact relationship between ISO, VOI and PIR preferences?

Second, the risk literature has provided ample empirical evidence of systematic violations of EU theory (the Allais paradox being the most famous example). A theoretical literature on non-expected utility (non-EU) models has developed mainly to accommodate these empirical violations.[4] It seems interesting to check whether these violations of EU theory for PIR preferences are also relevant for the ethical ranking of income distributions, that is, for ISO and VOI preferences. In fact, one of the most popular concepts from the non-EU literature, i.e. rank-dependent expected utility (RDEU), has in its simplified form (Yaari, 1987) received considerable attention in the income distribution literature because it provides a normative basis for an important subclass of the class of generalized Gini inequality indices.[5] Recent contributions have explored further links between the RDEU model in its general form and the measurement of inequality (Gajdos, 2001). How attractive are these non-EU approaches from an ethical point of view?

The present paper examines both issues through a questionnaire approach with Belgian students. We want to check whether their intuitions coincide with the formal approaches used by economists. In order to benefit from the accumulated knowledge in the risk literature, the set-up of our questionnaire will be analogous to the conventional approach used in that literature. We put respondents into three different choice contexts allowing revelation of ISO, VOI and PIR preferences, respectively. In each of these cases we test whether we discover any violations of the standard properties

[4] For overviews, see Camerer (1995) and Starmer (2000).

[5] To be precise, we are referring to the subclass that satisfies Dalton's Population Principle. See, for instance, Gajdos (2001) for details.

of the EU model. Such violations can also raise doubts about some of the standard assumptions in the literature on income distribution. Moreover, we will also check the empirical relevancy of the Yaari and RDEU models as well as that of some more basic non-EU concepts.

The questionnaire approach has recently become more popular in the economic literature on distributive justice. It has been used extensively for testing the acceptance of the crucial axioms from the literature on income distribution.[6] Recent work has explicitly compared the acceptability of these axioms for the income inequality and the risk setting (Amiel, Cowell and Polovin, 2001; Amiel and Cowell, 2002). Traub, Seidl and Schmidt (2003) and Camacho-Cuena, Seidl and Morone (2003) have run experiments in which subjects get material incentives to rank either income distributions or risky prospects. The close relationship between social welfare judgements and choice under risk and the theoretical suppositions of the EU approach are far from evident for large groups of respondents. Closest related to our work is a questionnaire study by Bernasconi (2002). He also checks the relevance of EU axioms for ISO, VOI and PIR preferences. The formulation of our questions is very different, however, and we go further in testing explicitly some non-EU alternatives. Despite these differences, some of our results turn out to be similar to those of Bernasconi.

The paper is organized as follows. Section 2 gives an overview of relevant findings from EU theory and non-EU theory and links these to the evaluation of income distributions. The actual questionnaire study is presented in Section 3. In Section 4 we present the results. Section 5 concludes.

2 (Non-)Expected Utility Theory and the Evaluation of Income Distributions

We first consider EU theory (Subsection 2.1) and some basic concepts from non-EU theory (Subsection 2.2). In Subsection 2.3 we summarize the basic characteristics of the RDEU model and of Yaari's theory. Finally, in Subsection 2.4, we return to the evaluation of income distributions.

We use the following notation. The set of incomes is $X = \{x_1, x_2, \ldots, x_n\}$, where the incomes are indexed such that $x_1 \leq \cdots \leq x_n$. An income distribution is a vector $\mathbf{p} = (p_1, \ldots, p_n)$ with $p_i \in [0, 1]$ for all i and $\sum_{i=1}^{n} p_i = 1$, where p_i is the proportion of the population with income x_i. In the case of individual decision under risk, income distributions have to be interpreted

[6] The most influential work is by Amiel and Cowell, who summarize their most important findings in Amiel and Cowell (1999). See also Harrison and Seidl (1994a, 1994b).

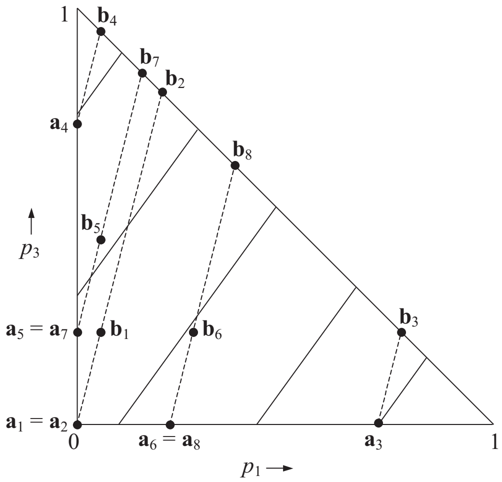

Figure 1: EU Indifference Curves in the Marschak-Machina Triangle

as lotteries, where p_i is the probability of outcome x_i. Preferences over alternatives, either income distributions or lotteries, are captured by a binary relation $\succeq$ ("is at least as good as"). The relation has an asymmetric factor $\succ$ ("is better than"), and a symmetric factor $\sim$ ("is equally good as"). Under certain conditions, a function, F, can be used to represent preferences. The function F has to be interpreted either as a social welfare function or as an individual utility function, depending on the given choice situation.

A convenient representation to compare the implications of EU theory with the implications of various non-EU theories is the so-called Marschak-Machina triangle[7] (see Figure 1). Focusing on lotteries with only three possible outcomes (or income distributions with only three income levels) $x_1 < x_2 < x_3$, each alternative can be written as a pair (p_1, p_3), with p_2 determined implicitly as $p_2 = 1 - p_1 - p_3$. Since, furthermore, for $i = 1, 2, 3$, it holds that $p_i \in [0, 1]$, all these alternatives are points in the triangle $\left\{(p_1, p_3) \in \mathbb{R}^2_+ \,|\, p_1 + p_3 \leq 1\right\}$. In the Marschak-Machina triangle of Figure 1 the different points represent thirteen possible alternatives. Our questionnaire study will focus on eight pairwise choices: each choice problem, $j = 1, \ldots, 8$, involves a choice among a pair of alternative lotteries or income

[7]This graphical device was introduced into the literature by Marschak (1950) and popularized by Machina (1982). It has since been used in many empirical studies concerning individual decision under risk.

Table 1: The Choice Pairs, $(p_1,\, p_2,\, p_3)$

Question	**a**	**b**
1	(0, 1, 0)	(0.05, 0.75, 0.2)
2	(0, 1, 0)	(0.2, 0, 0.8)
3	(0.75, 0.25, 0)	(0.8, 0, 0.2)
4	(0, 0.25, 0.75)	(0.05, 0, 0.95)
5	(0, 0.8, 0.2)	(0.05, 0.55, 0.4)
6	(0.2, 0.8, 0)	(0.25, 0.55, 0.2)
7	(0, 0.8, 0.2)	(0.16, 0, 0.84)
8	(0.2, 0.8, 0)	(0.36, 0, 0.64)

distributions $(\mathbf{a}_j, \mathbf{b}_j)$. Note that the dotted lines connecting each of these pairs of alternatives have the same slope equal to four. The probabilities corresponding to the specific options represented in Figure 1 are shown in Table 1.

2.1 Expected Utility Theory

Let us first summarize in a loose way the basic idea of expected utility (EU) theory. Suppose that all the alternatives can be ordered (implying that the preference relation is reflexive, transitive and complete) and that this ordering is continuous and monotonic. Suppose moreover that the following condition holds:

Independence. For any alternatives $\mathbf{p}, \mathbf{q}$ and $\mathbf{r}$ and any scalar $\alpha \in (0, 1)$, it holds that $\mathbf{p} \succeq \mathbf{q}$ if and only if $\alpha\mathbf{p} + (1-\alpha)\mathbf{r} \succeq \alpha\mathbf{q} + (1-\alpha)\mathbf{r}$.

Under these assumptions, preferences over alternatives can be represented by

$$F(\mathbf{p}) = \sum_{i=1}^{n} p_i u(x_i), \tag{1}$$

where u is a strictly increasing function. This condition on u ensures monotonicity, which means that (first order) stochastically dominating alternatives are preferred. Strong risk aversion, implying that mean preserving spreads are disapproved, requires that u be strictly concave.

Expression (1) has very strong implications for alternatives in the triangle diagram. In fact, it is immediately clear that the slope of the implied indifference curves is

$$\left.\frac{dp_3}{dp_1}\right|_{F=\bar{F}} = \frac{u(x_2) - u(x_1)}{u(x_3) - u(x_2)}, \tag{2}$$

which is constant (since the incomes x_1, x_2 and x_3 are given for all points in the triangle) and positive (since under monotonicity $u(x_3) > u(x_2) > u(x_1)$).

Positivity of the slope of indifference curves is a general property of preference theories that respect monotonicity. Note that monotonicity also implies that indifference curves lying more to the northwest correspond to higher preference. For any point $\mathbf{p}$ in the triangle, the set of points strictly to the northwest of $\mathbf{p}$ (that is, all points $\mathbf{q}$ such that $q_1 \leq p_1$ and $q_3 \geq p_3$, with at least one of the inequalities strict) constitutes the set of points strictly stochastically dominating $\mathbf{p}$.

The important distinguishing implication of EU theory, however, is the fact that the slope of these indifference curves is constant.[8] Thus, in EU theory, indifference curves are parallel straight lines. The continuous lines in Figure 1 represent such a set of EU indifference curves. One number, the value of the constant slope, determines the preferences over the entire triangle diagram. The figure shows that this feature severely restricts the number of response patterns allowed. In fact, EU theory implies that respondents choose consistently either **a** or **b** or are indifferent in each of the eight choice pairs. With the indifference curves drawn in the figure, this choice should be **b**. With a larger value for the slope it could be indifference or **a**. Note that in EU theory the slope can be seen as a kind of measure for the degree of risk aversion—in a choice between a certain lottery and a risky one, such as in pairs 1 and 2 in the figure, the certain one is chosen only for sufficiently high values of the slope.[9]

2.2 Some Basic Concepts from Non-Expected Utility Theory

The well-known problems discovered by Allais (1953) offer an important challenge to the restrictive implications of EU theory. The first three choice

[8] Of course, the slope is not required to be equal across different triangles, when different sets X are considered.

[9] Indeed, Machina (1982) has shown that the slope of the EU model, given in expression (2), is related to the Arrow-Pratt measure of risk aversion.

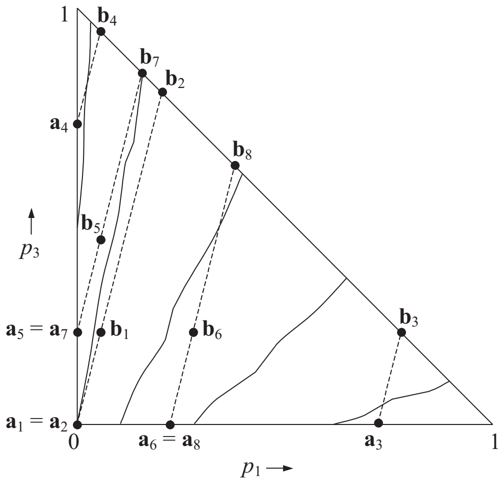

Figure 2: Fanning-out

pairs in Figure 1 are selected so as to illustrate these problems. Allais' "common consequence effect" (also known as the Allais paradox) suggests a tendency for choosing **a** in choice pair 1 and **b** in choice pair 3, thus violating EU theory. Allais' "common ratio effect" concerns a tendency for choosing **a** and **b**, respectively, in choice pairs such as 2 and 3, again violating EU theory. There is by now overwhelming experimental evidence for the empirical relevancy of both predictions (Camerer, 1995; Starmer, 2000).

One solution for "explaining" the Allais problems is dropping the assumption of parallel indifference curves. In fact, Machina (1982) introduced for that purpose the notion of *fanning-out*. In its pure form, fanning-out represents a monotonic increase in the slope of indifference curves as one moves northwest in the triangle (Figure 2). More specifically, it says that, given any two points $\mathbf{p}$ and $\mathbf{q}$ in the triangle, such that $\mathbf{q}$ lies to the northwest of $\mathbf{p}$ (that is, $\mathbf{q}$ stochastically dominates $\mathbf{p}$), the slope in point $\mathbf{q}$ has to be at least as high as that in $\mathbf{p}$. For the choice pairs in the figures, fanning-out has the following implications: given any two choice pairs k and l, if $\mathbf{a}_l$ stochastically dominates $\mathbf{a}_k$ and $\mathbf{b}_l$ stochastically dominates $\mathbf{b}_k$, then the choice of alternative $\mathbf{a}$ from pair k implies that alternative $\mathbf{a}$ has to be chosen from pair l as well, indifference in pair k implies that either alternative $\mathbf{a}$ has to be chosen from pair l or that one has to be indifferent between the alternatives of l. Fanning-out therefore accounts for the dominant behaviour in situations such as those suggested by Allais.

Empirical research, however, sometimes reveals the opposite pattern: that of *fanning-in* (see, e.g., Battalio, Kagel and Jiranyakul, 1990). In that case, the slope of the indifference curves becomes smaller as one moves to stochastically dominating alternatives. For the choice pairs in the figures, fanning-in has the following implications: given any two choice pairs k and l, if $\mathbf{a}_l$ stochastically dominates $\mathbf{a}_k$ and $\mathbf{b}_l$ stochastically dominates $\mathbf{b}_k$, then the choice of alternative $\mathbf{b}$ in k implies that alternative $\mathbf{b}$ has to be chosen in l as well, indifference in k implies that either alternative $\mathbf{b}$ has to be chosen in l or that one has to be indifferent between the alternatives of l.

Both fanning-out and fanning-in deal with a change in slope as one moves to different indifference curves (at least when preferences satisfy monotonicity). The research on extensions of EU theory has also focused on the relevancy of the linearity of the indifference curves implied by expressions (1) and (2). Three different assumptions have been proposed:

Betweenness. For any alternatives $\mathbf{p}$ and $\mathbf{q}$ and any scalar $\alpha \in (0,1)$, it holds that $\mathbf{p} \succeq \mathbf{q}$ if and only if $\mathbf{p} \succeq \alpha\mathbf{p} + (1-\alpha)\mathbf{q} \succeq \mathbf{q}$.

Quasi-convexity. For any alternatives $\mathbf{p}$ and $\mathbf{q}$ and any scalar $\alpha \in (0,1)$, $F(\alpha\mathbf{p} + (1-\alpha)\mathbf{q}) \leq \max\{F(\mathbf{p}), F(\mathbf{q})\}$.

Quasi-concavity. For any alternatives $\mathbf{p}$ and $\mathbf{q}$ and any scalar $\alpha \in (0,1)$, $F(\alpha\mathbf{p} + (1-\alpha)\mathbf{q}) \geq \min\{F(\mathbf{p}), F(\mathbf{q})\}$.

Betweenness obviously is an implication of independence. It implies that, if $\mathbf{p} \sim \mathbf{q}$, then for any scalar $\alpha \in (0,1)$ it holds that $\mathbf{p} \sim \alpha\mathbf{p} + (1-\alpha)\mathbf{q} \sim \mathbf{q}$, which means that indifference curves are straight lines—but not necessarily parallel. Betweenness implies neutrality to mixtures of alternatives on the same indifference curve. Straightforward extensions are concave indifference curves (corresponding to the assumption of quasi-convexity), describing mixture aversion, and convex indifference curves (corresponding to the assumption of quasi-concavity), describing mixture proneness. The latter case is illustrated in Figure 3. Betweenness, quasi-convexity and quasi-concavity have implications for the combinations of choice pairs (1, 2), (5, 7), and (6, 8) in the figures. In each of those combinations, the only response patterns consistent with betweenness are **aa**, **bb** and $\sim\sim$. Quasi-convexity allows, in addition to the betweenness patterns, **ab**, **a**$\sim$ and $\sim$**b**. Quasi-concavity, on the other hand, allows, in addition to the betweenness patterns, **ba**, **b**$\sim$ and $\sim$**a**.

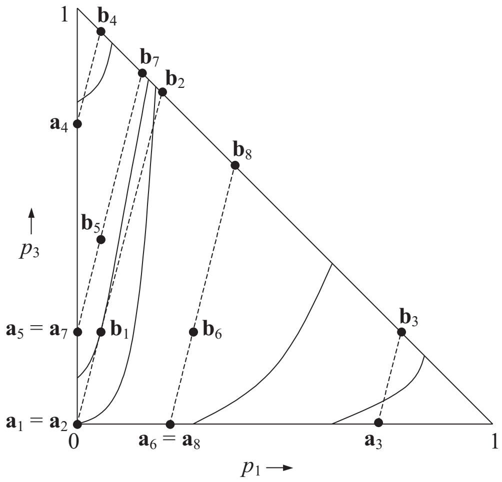

Figure 3: Quasi-concavity

2.3 Rank-dependent Expected Utility and Yaari's Dual Theory

The most popular alternative to the EU model, at least for economists (see, e.g., Starmer, 2000), is Quiggin's (1982) rank-dependent expected utility (RDEU) model. Most popular within the income distribution literature is Yaari's (1987) dual theory, which is a special case of the RDEU model. We will first summarize Yaari's model and then return to the more general RDEU approach.

If preferences are consistent with Yaari's theory, they can be represented by

$$F(\mathbf{p}) = \sum_{i=1}^{n} w(p_i, p_1 + \cdots + p_i)\, x_i, \tag{3}$$

where for any $i \neq n$

$$w(p_i, p_1 + \cdots + p_i) = f(p_i + \cdots + p_n) - f(p_{i+1} + \cdots + p_n)\,,$$

$w(p_n, p_1 + \cdots + p_n) = f(p_n)$ and $f : [0,1] \to [0,1]$ is a strictly increasing and continuous function for which $f(0) = 0$ and $f(1) = 1$. Given the conditions on f, preferences are monotonic. Strong risk aversion requires that f be strictly convex (Yaari, 1987). Note that while in the EU approach a change in an income is evaluated in function of the size of the income, in

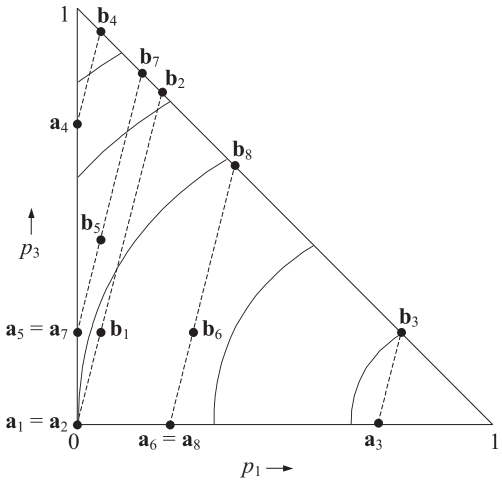

Figure 4: RDEU (Yaari) Indifference Curves

the Yaari approach it is evaluated as a function of its rank position (defined as $p_1 + \cdots + p_i$ for an income x_i).

For the alternatives in the triangle diagram, Yaari's theory implies that

$$F(\mathbf{p}) = [1 - f(1 - p_1)]\, x_1 + [f(1 - p_1) - f(p_3)]\, x_2 + f(p_3)\, x_3, \tag{4}$$

which yields for the slope of the indifference curves

$$\left.\frac{dp_3}{dp_1}\right|_{F=\bar{F}} = \frac{f'(1 - p_1)}{f'(p_3)} \frac{x_2 - x_1}{x_3 - x_2}. \tag{5}$$

Again, indifference curves are positively sloped (since $f'(p) > 0$ for all p). If f is strictly convex, the slope decreases as p_1 increases, ceteris paribus, and also as p_3 increases, ceteris paribus. If p_1 decreases and p_3 increases, the slope does not necessarily go up or down. This means that indifference curves strictly fan out horizontally—that is, the slope becomes strictly higher moving horizontally west in the triangle diagram—and strictly fan in vertically—that is, the slope becomes strictly smaller moving vertically north in the triangle diagram. Moving diagonally northwest, however, the slope can go up or down. This pattern is illustrated in Figure 4. By consequence, for the choices in the figures, fanning-out has to hold for combinations of the choice pairs 1, 3 and 6 (an horizontal move in the triangle), while fanning in has to hold for combinations of the choice pairs 1, 4 and 5 (a vertical move). There are no implications concerning fanning-out or fanning-in for combinations of choices 2, 3, 4, 7 and 8.

Another important property is that, whenever f is strictly convex, the slope of an indifference curve decreases as one moves to the northeast. Therefore, under the assumption of strong risk aversion, indifference curves are strictly concave (preferences are strictly quasi-convex).

The Yaari model is a special case of the RDEU model. The latter model is given by

$$F(\mathbf{p}) = \sum_{i=1}^{n} w(p_i, p_1 + \cdots + p_i)\, u(x_i), \tag{6}$$

where for any $i \neq n$

$$w(p_i, p_1 + \cdots + p_i) = f(p_i + \cdots + p_n) - f(p_{i+1} + \cdots + p_n)\,,$$

$w(p_n, p_1 + \cdots + p_n) = f(p_n)$, $f : [0,1] \to [0,1]$ is a strictly increasing and continuous function for which $f(0) = 0$ and $f(1) = 1$ and u is a strictly increasing function. Again the conditions required for monotonicity are satisfied. Strong risk aversion requires that the function f be convex and that the function u be concave and, furthermore, that either f be strictly convex or u be strictly concave or both (Chew, Karni and Safra, 1987). When u is the identity function, the RDEU model (6) reduces to the Yaari model. When f is the identity function, it reduces to the EU model.

The slope of an indifference curve in the triangle diagram for the RDEU model is

$$\left.\frac{dp_3}{dp_1}\right|_{F=\bar{F}} = \frac{f'(1-p_1)}{f'(p_3)} \frac{u(x_2) - u(x_1)}{u(x_3) - u(x_2)}. \tag{7}$$

Clearly, the indifference curves of the RDEU social welfare function have (more or less) the same properties as those of the Yaari model. That is, indifference curves are concave, fan out horizontally and fan in vertically.

2.4 Evaluating Income Distributions

There is a close formal relationship between the literature on income distribution and the theory of decision making under risk. With the Gini index as a prominent exception, the most common inequality measures (including the Atkinson-Kolm and the generalized entropy measures) can all be interpreted in a social welfare framework formally equivalent to the EU model as given in expression (1). This means that they can be interpreted as reflecting VOI-preferences, i.e. the preferences of a rational individual behind the veil of ignorance.[10] Of course one can also defend EU-type assumptions without explicitly referring to the idea of the veil of ignorance. One then has to justify the independence condition for ISO preferences directly on ethical grounds rather than as a requirement of rationality behind the veil of ignorance.

A strong competitor of the Atkinson-Kolm and the generalized entropy measures is the class of generalized Gini indices. These are based on a social welfare function of the form of the Yaari model (3) (or, at least, an important subclass is) and therefore do not satisfy the independence condition. The most popular social welfare function of the form (3) is the S-Gini social welfare function, where $f(p) = p^{\rho}$ with $\rho > 1$ (Donaldson and Weymark, 1980, Yitzhaki, 1983). The parameter ρ can be seen as a measure for the degree of inequality aversion. Note that the popular Gini index is based on the S-Gini social welfare function with $\rho = 2$. A few studies such as Ebert (1988) and more recently Chateauneuf (1996) and Chateauneuf, Gajdos and Wilthien (2002), have considered the evident extension to the Yaari model which is to base the evaluation of income distributions on the RDEU model.

The idea of strong risk aversion is interpreted within the income distribution literature as the Pigou-Dalton transfer principle, i.e. the notion that a rank preserving transfer from a rich to a poor person increases social welfare. As we have seen, the transfer principle requires in the EU model that the function u be strictly concave. This assumption does not affect the response patterns compatible with EU theory for the choice pairs in the triangle diagram of Figure 1, however. As can be seen from expression (2) the restriction to linear parallel indifference curves does not depend on the concavity of u and a test of this restriction can be seen as a direct test of the independence assumption without any need to make assumptions about risk aversion.

On the other hand, imposing the transfer principle has stronger consequences for the Yaari and the RDEU models within the triangle. As we have seen, it requires, for instance, in both cases that the indifference curves be strictly concave. Since the transfer principle occupies such a dominant position in the income distribution literature, we will use in the empirical part the terms Yaari model and RDEU model for expressions (3) and (6), respectively, with the assumption of concave indifference curves imposed.

However, we know from previous empirical work that the transfer principle is violated consistently by respondents.[11] Let us therefore define the

[10] Dahlby (1987) explicitly works out this interpretation.

[11] This is found especially in the context of inequality comparisons (see for instance

weaker principle of “weak inequality aversion:” given a fixed population, it should always hold that a completely equal income distribution is better than any unequal income distribution with the same total income. This principle seems absolutely essential for an egalitarian social welfare function. It gives additional support for the transfer principle with an EU social welfare function, i.e. a social welfare function satisfying independence, because such a welfare function will only satisfy weak inequality aversion if it satisfies the transfer principle. However, in the Yaari (and RDEU) framework, weak inequality aversion does not imply the transfer principle. It has been shown (Chateauneuf, 1996) that the Yaari social welfare function (3) satisfies weak inequality aversion if and only if $f(p) < p$ for all $p \in (0, 1)$. This condition is strictly weaker than strict convexity (since $f(0) = 0$ and $f(1) = 1$). The RDEU social welfare function satisfies weak inequality aversion if $f(p) \leq p$ for all $p \in (0, 1)$ and u is concave, with at least one of the conditions holding in its strict version.[12] In our empirical work we will consider these extensions as well and label them Yaari′ and RDEU′.

In the risk literature, forms of the RDEU weighting function f that do not satisfy the condition relating to weak inequality aversion have been considered and sometimes offer a better explanation of observed choice patterns (see, e.g., Gonzalez and Wu, 1999). We do not consider these forms in our empirical analysis because in our view it does not make sense to base the evaluation of income distributions on a welfare function which does not even satisfy the principle of weak inequality aversion.

3 The Setting of the Questionnaire

The target group of the questionnaire consisted of first year business students of the K.U.Leuven (Catholic University Leuven, Belgium), who had not yet

Amiel and Cowell, 1992, 1998, Ballano and Ruiz-Castillo, 1993, and Harrison and Seidl, 1994a, 1994b), but also in the context of social welfare comparisons (Amiel and Cowell, 1994).

[12]In fact, Chateauneuf (1996) has shown that these conditions for the Yaari and RDEU models imply consistency with the “absolute differentials ordering,” which is a stronger requirement than the one of weak inequality aversion. This stronger principle can be formulated as follows. Suppose that we have two income distributions with the same population and total income, and in the first income distribution the absolute income difference for each income pair is greater than, or equally great as, in the second distribution while for at least one pair the absolute income difference is greater, then the first income distribution is more unequal than the second. It seems natural to extend the principle to the social welfare context by stating that the second income distribution should be evaluated as better than the first.

been exposed to any lectures on the evaluation of income distributions or on decision making under risk. The questionnaires were distributed and filled in in the classroom, after the teacher had given a short and non-suggestive oral introduction. The survey was organized twice (with different respondents in two subsequent academic years): in April 2002 and in November 2002. The results were stable over time. In order to test for the differences between ISO, VOI and PIR preferences, there were three different versions of the questionnaire. Accordingly, the group of students was divided into three subgroups. Each subgroup participated in only one version of the questionnaire and respondents did not know that there were three different versions. For the ISO version, the VOI version and the PIR version, there are 93, 92 and 94 respondents, respectively.

Each questionnaire version consists of the same eight questions, where in each question, the respondent is asked to make a choice between two alternatives, which are either income distributions or lotteries, depending on the given choice situation. The eight choice pairs correspond to the alternatives shown in Figure 1 (with the probabilities as given in Table 1). Throughout the questionnaire, the same set of three incomes $X = \{x_1 = €500, x_2 = €1500, x_3 = €2500\}$ is used. In line with the Allais problems described earlier, we refer to questions 1, 3, 4, 5 and 6 as the "common consequence questions," and to questions 2, 3, 4, 7 and 8 as the "common ratio questions."

Although the same choice pairs are used, the background stories are different for the three versions of the questionnaire.[13] Each of the three versions deals with recently graduated students that are going to be employed in one of two firms. Each firm offers three types of jobs which are identical in every respect except for the income that is earned: the first job pays €2500, the second €1500 and the third €500. For the ISO and VOI versions, a firm corresponds to an income distribution, for the PIR version it corresponds to a lottery.

In the ISO version, the respondent is asked to consider the situation of 100 recently graduated students that will all be employed in either of two firms, which are different only with respect to the number of positions that are available for each of the jobs. The respondent is then asked to reveal, for the eight cases, which of the two firms he or she thinks offers the largest social welfare.

[13] The precise formulation of the background stories in each of the versions is given in Appendix A. For each background story there were two variants of the questionnaire with the questions ordered differently. Since the results show that there is only a slight indication of order effects, we simply pooled the answers for these different variants.

The VOI version also asks the respondent to consider the situation of 100 recently graduated students, but this time the respondent has to picture himself or herself as being one of them. Again, the firms are different only with respect to the number of positions that are available for each of the jobs. The respondent and the 99 other graduated students will all be employed in the same firm and each has an equal chance of ending up in any of the 100 positions available in the firm. The respondent is then asked to state, for each of the eight cases, which firm he or she prefers.

In the PIR version, the respondent is asked to picture himself or herself as being a recently graduated student who will be employed in either of two firms. The firms are identical except with respect to the probabilities of ending up with each of the jobs. The respondent is then, again, asked to state, for each of the eight cases, which firm he or she prefers.

As mentioned already in the introduction, the setting of our questionnaire is similar to the one used by Bernasconi (2002). There are three main differences, however. First, we use different and more income distributions (and therefore test some axioms which could not be tested by him). Second, he represents the different income distributions in the questionnaires with pie charts, while we simply give the relevant sets of numbers. Third, he formulates the ISO, VOI and PIR cases in a more abstract form, while we tried to formulate a question which was closer to the everyday experience of our respondents. The comparison of his results with ours will therefore give some insight into the importance of framing effects (for which, again, see Camerer, 1995).

4 Results

Our discussion of the results focuses on the two general issues raised before: the comparison of the ISO, VOI and PIR versions of the questionnaire, and the degree of consistency with the preference theories presented in Section 2. In Subsection 4.1 we have a first look at the question of how the three versions of the questionnaire compare through an analysis of the responses for separate questions. Combining the answers on different questions makes it possible to test also the relevancy of the different basic axioms of choice theory (Subsection 4.2). In Subsection 4.3 we conclude the discussion by focusing on the different theories which have been proposed in the income distribution literature.

Table 2: Results for Separate Questions (in %)

	ISO			VOI			PIR		
Question	**a**	**b**	$\sim$	**a**	**b**	$\sim$	**a**	**b**	$\sim$
1	37	59	4	26	72	2	27	69	4
2	50	45	5	45	51	4	58	43	0
3	30	66	4	20	77	3	17	78	5
4	61	37	2	38	57	5	28	69	3
5	44	55	1	29	67	3	35	62	3
6	19	76	4	16	82	2	35	63	2
7	56	42	2	41	53	5	51	43	6
8	30	61	9	36	60	4	48	45	8

4.1 A First Look

Table 2 and Figure 5 give the results for the separate questions. The chi-square test statistics reported in Table 3 test for each question separately the null hypothesis that population proportions for categories **a** and **b**, respectively, are equal for the two versions under comparison (ISO-VOI, VOI-PIR or ISO-PIR) (there is one degree of freedom).[14] To some extent Table 3 suggests that the results for the ISO and PIR versions are furthest removed from each other while the results for the VOI version lie in between. This is exactly what one would expect a priori: ISO preferences deal exclusively with uninvolved common interest, PIR preferences deal exclusively with involved self interest and VOI preferences deal with involved common interest (that is, the common interest is at stake). We will see that this pattern is confirmed in more detailed analyses.

Table 2 shows that, overall, alternative **b** is more popular than the other two alternatives. In the risk literature **b** alternatives are usually seen as more risky than the corresponding **a** alternatives. Analogously, we could say that they are more unequal in the income distribution context. The

[14] We ignore the category of indifference ($\sim$) in the tests because it usually has frequencies lower than five, which would make the chi-square test less appropriate.

Table 3: Chi-square Tests for Homogeneity for Separate Questions

Question	ISO-VOI	VOI-PIR	ISO-PIR
1	2.72	0.03	2.20
	(0.099)	(0.867)	(0.138)
2	0.57	2.15	0.49
	(0.451)	(0.143)	(0.483)
3	2.93	0.15	4.35
	(0.087)	(0.703)	(0.037)
4	8.94	2.68	21.29
	(0.003)	(0.101)	(0.000)
5	3.91	0.71	1.31
	(0.048)	(0.399)	(0.253)
6	0.38	8.64	5.47
	(0.539)	(0.003)	(0.019)
7	3.23	2.07	0.12
	(0.073)	(0.151)	(0.726)
8	0.39	3.58	6.21
	(0.530)	(0.058)	(0.013)

Note: p-values between brackets.

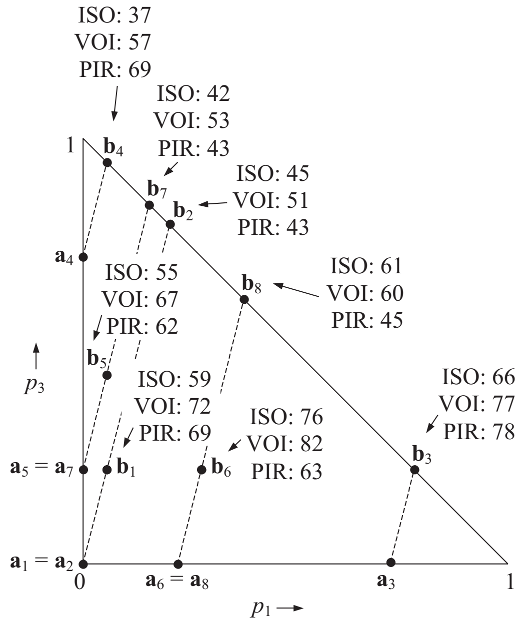

Figure 5: Overview of the Results, **b** Responses (in %)

popularity of the **b** answers can be explained by the choice of the set of incomes in our questionnaire design. Consider as a benchmark the case of a respondent who has preferences consistent with the Atkinson social welfare function: for the given income amounts, such a respondent only prefers **a** over **b** if she has a relatively high value of 2.5 or more for the parameter of inequality aversion.

4.2 Testing Some Concrete Hypotheses of Choice Theory

More interesting insights can be gained by analysing the response patterns for different choice pairs together. We will first look at combinations of two questions and then analyse the overall response patterns for the eight questions. We focus, again, on the two main issues. In the first place, we test the empirical relevancy of the concrete hypotheses of choice theory. In the second place, we check for the possible differences between ISO, VOI and PIR preferences.

4.2.1 Pairs of Questions

(a) Tables 4 and 5 show the results for combinations of several pairs of common consequence questions and common ratio questions, respectively. For each combination of two choice pairs (described in the first column) we give separately the results for the three versions of the questionnaire. As shown in Subsection 2.1, only three of the nine possible response patterns are consistent with EU theory for each of the combinations of two questions included in Tables 4 and 5: the respondent can prefer **a** in both choice pairs, she can prefer **b** in both pairs or she can be indifferent ($\sim$) in both choice situations. We call these patterns, (**aa**, **bb**, $\sim\sim$), therefore "EU consistent" and the percentage of respondents with one of these three response patterns is given in the third column of Tables 4 and 5. Analogously we can say that the response patterns (**ba**, **b**$\sim$, $\sim$**a**) and (**ab**, **a**$\sim$, $\sim$**b**) are consistent with indifference curves that fan out and fan in, respectively. In both cases we exclude EU consistent patterns from the categories fanning-out and fanning-in. The percentages of respondents with these patterns are given in the last two columns of the tables.

Clearly, EU consistent responses dominate. One should be aware that this does not necessarily imply that our respondents follow the axioms of EU theory, as it is quite possible for an individual to be consistent with EU theory over two questions but not over three or more. We will return to this issue in the next section. At this stage it is more interesting to consider whether the violations of EU theory for each of the question pairs are systematic, that is, whether the percentage of observed patterns consistent with fanning-out (or fanning-in) is significantly higher than the percentage that would be observed if the response patterns of the respondents that violate EU theory were completely random. The null hypothesis is that the population frequency of fanning-out (or fanning-in) violations relative to the total population frequency of violations is equal to 50%. The tables report p-values for the one sided exact test based on the binomial distribution.

The first combinations of choice pairs in Tables 4 and 5, the combinations (3, 1) and (3, 2), are of particular interest, as they are similar to the original examples used by Allais for introducing the common consequence and common ratio effects, respectively.

In both cases the predicted fanning-out patterns are more popular than the fanning-in patterns. The statistical significancy of fanning-out is much weaker for Allais' common consequence effect (questions 3 and 1) than for Allais' common ratio effect (questions 3 and 2).

The overall picture shows some interesting differences between the ISO,

Table 4: Results for Pairs of Common Consequence Questions (in %)

Questions	Version	EU (**aa**, **bb**, ∼∼)	Fanning-out (**ba**, **b**∼, ∼**a**)	Fanning-in (**ab**, **a**∼, ∼**b**)
3, 1	ISO	61	23	16
			(0.203)	
	VOI	63	22	15
			(0.196)	
	PIR	63	23	14
			(0.088)	
1, 4	ISO	53	35	12
			(0.001)	
	VOI	60	26	14
			(0.049)	
	PIR	55	22	22
			(0.562)	
3, 6	ISO	61	14	25
				(0.066)
	VOI	73	12	15
				(0.345)
	PIR	62	27	12
			(0.014)	
6, 1	ISO	55	31	14
			(0.010)	
	VOI	67	22	11
			(0.049)	
	PIR	63	14	23
				(0.088)
1, 5	ISO	67	19	14
			(0.237)	
	VOI	72	16	12
			(0.279)	
	PIR	66	21	13
			(0.108)	
5, 4	ISO	62	28	10
			(0.003)	
	VOI	54	27	18
			(0.140)	
	PIR	63	15	22
				(0.155)

Note: p-values between brackets.

Table 5: Results for Pairs of Common Ratio Questions (in %)

Questions	Version	EU (**aa**, **bb**, $\sim\sim$)	Fanning-out (**ba**, **b**$\sim$, $\sim$**a**)	Fanning-in (**ab**, **a**$\sim$, $\sim$**b**)
3, 2	ISO	55	33	12
			(0.001)	
	VOI	57	36	8
			(0.000)	
	PIR	51	45	4
			(0.000)	
2, 4	ISO	56	27	17
			(0.106)	
	VOI	62	15	23
				(0.155)
	PIR	57	6	36
				(0.000)
3, 8	ISO	62	20	17
			(0.368)	
	VOI	60	29	11
			(0.004)	
	PIR	53	41	5
			(0.000)	
8, 2	ISO	61	29	10
			(0.002)	
	VOI	52	29	18
			(0.087)	
	PIR	64	21	15
			(0.196)	
2, 7	ISO	68	17	15
			(0.428)	
	VOI	62	17	21
				(0.368)
	PIR	67	16	17
				(0.500)
7, 4	ISO	60	23	17
			(0.256)	
	VOI	62	17	21
				(0.368)
	PIR	56	9	35
				(0.000)

Note: p-values between brackets.

VOI and PIR versions of the questionnaire. A mixed pattern of fanning-out and fanning-in is observed in the PIR version. This is in line with the experimental research on decision making under risk. However, with only one exception, fanning-out is always dominating in the ISO version. The VOI version is between the other two, but with a relatively strong presence of fanning-out. Table 6 presents the chi-square test statistics for the hypothesis of homogeneity of two versions with respect to the categories EU, fanning-out and fanning-in between versions (there are two degrees of freedom).[15] The hypothesis formulated on the basis of Table 3 is corroborated by the results in Table 6: the results for the ISO and PIR versions form the extremes while the results for the VOI version are situated in between.

The question pairs in Table 4 also allow to test for some aspects of the Yaari and RDEU models (with the Pigou-Dalton transfer principle imposed). As we have seen (Subsection 2.3), these models imply that fanning-out holds horizontally, that is, for the question pairs (3, 1), (3, 6) and (6, 1), while fanning-in holds vertically, and thus for the question pairs (1, 4), (1, 5) and (5, 4) (of course, the EU patterns for these pairs are also consistent with the models). This pattern is not supported by the results for the ISO and VOI versions, especially where the Yaari and RDEU models imply fanning-in.

(b) Table 7 gives the results for the question pairs (6,8), (1,2) and (5,7). These combinations allow to test betweenness, i.e. the linearity of indifference curves (which is EU consistent) against quasi-convexity (excluding EU consistent patterns) and quasi-concavity (again, excluding EU consistent patterns). The corresponding response patterns have already been described in Section 2.2. The results in Table 7 are striking. There is a clear and significant domination of quasi-concavity, i.e. convex indifference curves. This mixture proneness is found in all three versions of the questionnaire.[16] Quasi-concavity has also been found in experimental work on decision making under risk (see, e.g., Camerer and Ho, 1994). Its implications for welfare analysis, however, are important. We mentioned already that imposition of the transfer principle in the Yaari and RDEU models implies quasi-convex preferences. We will return to the implications of these findings in Section 4.3.

[15] Note the difference with Table 3, in which we tested for homogeneity of the three versions with respect to the responses (**a** or **b**) for the eight separate questions. Table 6 tests for homogeneity of the three versions with respect to response patterns (EU consistent, fanning-out or fanning-in) for combinations of two questions.

[16] Chi-square tests show that the null hypothesis of homogeneity over the versions cannot be rejected.

Table 6: Chi-square Tests for Homogeneity for Pairs of Questions

Questions	ISO-VOI	VOI-PIR	ISO-PIR
3, 1	0.06	0.12	0.2
	(0.969)	(0.942)	(0.907)
1, 4	1.93	2.15	5.88
	(0.381)	(0.342)	(0.053)
3, 6	3.16	6.43	8.03
	(0.206)	(0.040)	(0.018)
6, 1	3.11	6.04	8.99
	(0.211)	(0.049)	(0.011)
1, 5	0.56	0.86	0.14
	(0.756)	(0.650)	(0.932)
5, 4	3.07	4.25	8.4
	(0.216)	(0.120)	(0.015)
3, 2	0.96	2.04	5.01
	(0.620)	(0.361)	(0.082)
2, 4	4.00	6.33	18.16
	(0.135)	(0.042)	(0.000)
3, 8	2.85	4.07	13.25
	(0.241)	(0.131)	(0.001)
8, 2	3.23	2.65	2.20
	(0.199)	(0.267)	(0.333)
2, 7	1.05	0.57	0.16
	(0.591)	(0.753)	(0.923)
7, 4	0.94	6.56	11.8
	(0.626)	(0.038)	(0.003)

Note: p-values between brackets.

Table 7: Results for Pairs of Questions (in %)

Questions	Version	EU (**aa**, **bb**, ∼∼)	Quasi-convexity (**ab**, **a**∼, ∼**b**)	Quasi-concavity (**ba**, **b**∼, ∼**a**)
6, 8	ISO	57	15	28 (0.040)
	VOI	61	9	30 (0.001)
	PIR	54	14	32 (0.007)
1, 2	ISO	70	8	23 (0.006)
	VOI	61	9	30 (0.001)
	PIR	55	7	37 (0.000)
5, 7	ISO	63	13	24 (0.061)
	VOI	57	14	29 (0.019)
	PIR	53	14	33 (0.005)

Note: p-values between brackets.

Table 8: Results for the Combination of All Eight Questions (in %)

	EU	Fanning-out	Fanning-in	Betweenness	Quasi-convexity	Quasi-concavity
Reference	0.8	6.3	6.3	12.5	42.2	42.2
ISO	10	30	13	32	46	68
Test 1	(0.000)	(0.000)	(0.013)	(0.000)	(0.246)	(0.000)
Test 2		(0.000)	(0.889)	(0.002)	(0.854)	(0.001)
VOI	13	29	18	26	40	70
Test 1	(0.000)	(0.000)	(0.000)	(0.000)	(0.686)	(0.000)
Test 2		(0.000)	(0.570)	(0.393)	(0.998)	(0.003)
PIR	11	24	15	21	37	72
Test 1	(0.000)	(0.000)	(0.002)	(0.012)	(0.859)	(0.000)
Test 2		(0.002)	(0.762)	(0.675)	(0.999)	(0.000)

Note: p-values between brackets.

4.2.2 The Total Pattern of Answers

In Table 8 we summarize the results for a more ambitious approach in which the eight questions are considered jointly. Each column refers to a specific hypothesis of choice theory. We first give, for each hypothesis, as a reference point the proportion of the 256 ($= 2^8$) possible patterns that is actually consistent with the given hypothesis.[17] If individual response patterns were completely random, we would expect to find the "reference" degree of support for the various hypotheses. We then test whether the actual number of consistent response patterns in the data is significantly larger than what would be expected for random responses.[18] This test is labelled "Test 1" in Table 8.

For all three versions, all hypotheses except quasi-convexity pass Test 1. Note that about 10% to 13% of the observed patterns are consistent with EU theory—which is significantly more than the 0.8% which would

[17]For convenience, we have neglected patterns with indifferences. There are only very few cases of indifference in the answers of our respondents.

[18]More specifically, we test the null hypothesis that the population proportion in support of the given hypothesis of choice theory is equal to the population proportion in support of the same hypothesis if choices were completely random against the alternative hypothesis that it is greater.

be found with a completely random response pattern. An explanation of the success of EU theory could be that respondents use the expected value rule. At the same time it should be mentioned that 10% to 13% is far from overwhelming considering the focal role of EU theory in the risk and in the income distribution literature.

Since all the other hypotheses generalize EU theory, they all benefit from the relatively good performance of that theory. It is more revealing therefore to test whether they "add" something to EU theory. We do this by removing from the sample all EU consistent patterns. For the remaining (non-EU consistent) responses we follow an analogous procedure as described before. For each hypothesis (each column) we first compute, with respect to the set of all possible patterns excluding the EU consistent patterns, the proportion of consistent responses to be expected if individual response patterns were completely random. We then test whether the proportion of consistent responses in the (reduced) sample is significantly larger than what would be expected in the random case. The resulting p-values are summarized in Table 8 under the label "Test 2."[19]

For all three versions, fanning-out adds significantly to EU theory, while the fanning-in hypothesis does not. Looking at the shape of the indifference curves, betweenness adds explanatory power to EU theory for the ISO version, but not for the other versions. An approach with linear but non-parallel indifference curves in the Marschak-Machina triangle seems to have some relevance to describe the preferences of an impartial and sympathetic observer. However, more striking is the significance of quasi-concavity for all three versions. The global response patterns therefore confirm what we found already by analysing the combinations of choice pairs two by two.

4.3 The Fate of Different Theories of Income Distribution Evaluation

The importance of quasi-concavity and fanning-out already suggests that the most popular approaches in the income distribution literature will not get much support in our data. Table 9, which is constructed in a similar way as Table 8, summarizes the results in a more structured way. We repeat the

[19] More specifically, "Test 2" considers the null hypothesis that the population proportion in support of a specific non-EU hypothesis, excluding the part of the population that is in support of EU theory as well, is equal to what would be the population proportion in support of that non-EU hypothesis, excluding the part of the population that is in support of EU theory as well, if choices were random. The alternative hypothesis is that the former population proportion is greater than the latter.

Table 9: Results for the Combination of All Eight Questions (in %)

	EU	S-Gini	Yaari	RDEU	Yaari′	RDEU′
Reference	0.8	2.7	15.2	16.4	65.6	79.3
ISO	10	13	23	23	69	78
Test 1	(0.000)	(0.000)	(0.039)	(0.075)	(0.298)	(0.633)
Test 2		(0.273)	(0.708)	(0.805)	(0.895)	(0.990)
VOI	13	16	25	25	78	88
Test 1	(0.000)	(0.000)	(0.010)	(0.023)	(0.006)	(0.021)
Test 2		(0.268)	(0.794)	(0.869)	(0.518)	(0.829)
PIR	11	15	26	26	74	90
Test 1	(0.000)	(0.000)	(0.007)	(0.016)	(0.042)	(0.003)
Test 2		(0.113)	(0.496)	(0.621)	(0.627)	(0.440)

Note: p-values between brackets.

results for the EU model as a benchmark. Remember that the EU approach performs significantly better than what would be predicted if the answers were random. As shown by the results for "Test 1," the same is true for the S-Gini, the Yaari, the RDEU, the Yaari′ and the RDEU′ models (for the latter three only in the VOI and PIR versions).

However, in our set-up all these alternative theories are less restrictive than EU theory. In fact, each of them can also rationalize each pattern that is EU consistent.[20] We therefore want to test whether any of these theories adds some explanatory power to the EU model. Analogously to the previous section, we therefore computed again the "Test 2" results. For none of the versions, Yaari's theory or the (more restricted) S-Gini model passes this stricter test. Nor does the RDEU model. To repeat: this implies that the proportion of observed response patterns in the subsample of non-EU consistent responses which is consistent with these models is not significantly larger than what would be expected if the answers of the respondents were completely random. It is important to remember that we imposed the Pigou-Dalton transfer principle in the Yaari and the RDEU-model, i.e. convexity of the weighting function f, and that our results can only be seen as a test of this restricted model. Yet relaxation of this convexity condition does

[20] This is not a general property—but it holds for our set of specific questions within the Marschak-Machina triangle.

not seem to help very much, given the fate of the Yaari′ and the RDEU′ models, which only impose the property of weak inequality aversion. It is difficult to see how one could construct an attractive egalitarian theory of social welfare which does not satisfy this very weak property. Both models (Yaari′ and RDEU′) are quite flexible and it is therefore not surprising that the proportion of response patterns compatible with them is very high. Again, however, the models do not add significantly to EU, in the sense that randomly chosen patterns would have performed equally well.

These results seem to suggest that it is worthwhile to work out alternatives for the EU-type social welfare functions, i.e. to try and elaborate an alternative which does not embody the independence assumption. At the same time, however, the Yaari- and RDEU-type extensions with weak inequality aversion imposed do not seem to be very promising, at least when one wants to rationalize the preferences of our respondents (and they appear to be even less successful for the ISO than for the VOI or PIR version). Comparing Tables 8 and 9 it is striking how much better is the performance of other alternatives to the EU model like fanning-out and quasi-concavity. It remains to be seen whether these ideas can be integrated in an attractive theory of income distribution.

5 Conclusion

With our questionnaire study we wanted to test whether the veil of ignorance approach captures in an adequate way the preferences of an impartial and sympathetic observer. Moreover, we wanted to check whether the answers of our respondents satisfy the independence axiom—underlying EU theory and most approaches to inequality measurement—and its most popular alternatives. Both questions are related but different. One can accept the VOI approach and at the same time argue in favour of a non-EU model behind the veil of ignorance. And one can defend the independence assumption for inequality measurement without the detour of the veil of ignorance.

As to the first question, the results for the three questionnaire versions (ISO, VOI and PIR) are to a certain degree similar: both of Allais' problems are present, there is quite a lot of systematic fanning-out or fanning-in, and quasi-concavity is an important systematic violation of EU (or betweenness). However, there are differences and it appears that the ISO and PIR versions are at both extremes. The identification of ISO preferences with VOI preferences is not evident. Note that the results for the PIR version are reassuringly comparable to the results encountered in empirical studies from the literature on decision under risk: Allais' problems, a complex fanning pattern, systematic violations of betweenness.

The EU model yields a significant contribution to the explanation of the response patterns. At the same time, however, there are clear indications of the relevancy of fanning-out and quasi-concavity, also in the ISO version. Fanning-out and quasi-concavity do not characterize the most popular alternatives to the EU model—the RDEU model with as a special case the Yaari model, which provides the normative basis for an important subclass of the family of generalized Ginis. It is therefore not surprising that they do not add much explanatory power.

These are the results of only one limited study. However, they are in the line of much previous research on the empirical acceptance of the most popular inequality axioms. Moreover, despite the differences in the concrete formulation of the questionnaires and in the general set-up of the empirical study, some of our results are strikingly similar to those of Bernasconi (2002): he also finds that the equivalence of VOI and ISO preferences cannot be taken for granted and that quasi-concavity, i.e. mixture proneness, is important to explain the empirical results.

The conclusion that the traditional inequality literature does not adequately capture the intuitions of our respondents seems clear. Even if we take the Yaari and the EU model together only a quarter of our students shows a response pattern which is in line with one of them. Of course, one can reasonably argue that the normative relevancy of this kind of questionnaire results is limited, as they can never substitute for critical reflection and thorough assessment of the ethical argumentation. We do not go into that debate here. However, a conditional conclusion seems possible. *If* one wants to construct a theory of income distribution which is more attuned to the intuitions of lay respondents, the RDEU model with imposition of weak inequality aversion does not seem to be the most promising starting point.

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Appendix A.1: ISO Version

Consider the situation of two firms, A and B, that each plan to employ 100 recently graduated students. Assume that in each firm there are three types of jobs that are identical in all respects but yield a different monthly net income. The first job yields €2500, the second €1500 and the third €500. The firms differ however with respect to the numbers of positions they have available for each of the three jobs.

Evidently, due to the different distribution of incomes, the global welfare of the 100 employees can be different in the firms A and B. We are interested in your personal judgement of these welfare differences.

Indicate in each of the eight questions below which firm leads to the highest welfare according to you by marking A or B. So, the marked letter corresponds to the firm that you prefer from a welfare perspective. If you consider both firms to be equally good, then mark both letters. Of course each question needs to be treated separately and a different answer can be given in each case.

Question 1:

A:	B:
100 earn €1500 each	20 earn €2500 each
	75 earn €1500 each
	5 earn €500 each

Question 2:

A:	B:
100 earn €1500 each	80 earn €2500 each
	20 earn €500 each

Question 3:

A:	B:
25 earn €1500 each	20 earn €2500 each
75 earn €500 each	80 earn €500each

Question 4:

A:	B:
75 earn €2500 each	95 earn €2500 each
25 earn €1500 each	5 earn €500 each

Question 5:

A:	B:
20 earn €2500 each	40 earn €2500 each
80 earn €1500 each	55 earn €1500 each
	5 earn €500 each

Question 6:

A:	B:
80 earn €1500 each	20 earn €2500 each
20 earn €500 each	55 earn €1500 each
	25 earn €500 each

Question 7:

A:	B:
20 earn €2500 each	84 earn €2500 each
80 earn €1500 each	16 earn €500 each

Question 8:

A:	B:
80 earn €1500 each	64 earn €2500 each
20 earn €500 each	36 earn €500 each

Appendix A.2: VOI Version

Try to put yourself in the position of a recently graduated student who has to choose, just as 99 other recently graduated students, between accepting a job in firm A or in firm B. Assume that in each firm there are three types of jobs that are identical in all respects but yield a different monthly net income. The first job yields €2500, the second €1500 and the third €500. The firms differ however with respect to the numbers of positions they have available for each of the three jobs.

You and the 99 other recently graduated students either all end up in firm A or all in firm B. Each of the 100 of you has an equal probability of ending up in each of the 100 positions. So, it is unknown beforehand which job you will get.

Indicate in each of the eight questions below which firm you would prefer by marking A or B. So, the marked letter corresponds to the firm that would be preferred by you in this situation. If you consider both firms to be equally good, then mark both letters. Of course each question needs to be treated separately and a different answer can be given in each case.

Note: The formulation of the questions is identical to that of the ISO version in Appendix A.1. The questions are therefore omitted.

Appendix A.3: PIR Version

Try to put yourself in the position of a recently graduated student who has to choose between accepting a job in firm A or in firm B. Assume that in each firm there are three types of jobs that are identical in all respects but yield a different monthly net income. The first job yields €2500, the second €1500 and the third €500. The firms differ however with respect to the numbers of positions they have available for each of the three jobs. Beforehand it is not known with certainty which of the three possible jobs you will eventually get. Your chances are different in both firms.

Indicate in each of the eight questions below which firm you would prefer by marking A or B. So, the marked letter corresponds to the firm that would be preferred by you in this situation. If you consider both firms to be equally good, then mark both letters. Of course each question needs to be treated separately and a different answer can be given in each case.

Question 1:

A:	B:
100% chance that you earn €1500	20% chance that you earn €2500
	75% chance that you earn €1500
	5% chance that you earn €500

Question 2:

A:	B:
100% chance that you earn €1500	80% chance that you earn €2500
	20% chance that you earn €500

Question 3:

A:	B:
25% chance that you earn €1500	20% chance that you earn €2500
75% chance that you earn €500	80% chance that you earn €500

Question 4:

A:	B:
75% chance that you earn €2500	95% chance that you earn €2500
25% chance that you earn €1500	5% chance that you earn €500

Question 5:

A:	B:
20% chance that you earn €2500	40% chance that you earn €2500
80% chance that you earn €1500	55% chance that you earn €1500
	5% chance that you earn €500

Question 6:

A:	B:
80% chance that you earn €1500	20% chance that you earn €2500
20% chance that you earn €500	55% chance that you earn €1500
	25% chance that you earn €500

Question 7:

A:	B:
20% chance that you earn €2500	84% chance that you earn €2500
80% chance that you earn €1500	16% chance that you earn €500

Question 8:

A:	B:
80% chance that you earn €1500	64% chance that you earn €2500
20% chance that you earn €500	36% chance that you earn €500