Preferences over Consumption and Status

Alexander Vostroknutov*

Department of Economics, University of Minnesota, USA
Department of Economics, Maastricht University, The Netherlands

January 2009

Abstract

Experimental evidence suggests that individual consumption has not only personal value but also enters the social part of the utility. Existing models of social preferences make ad hoc parametric assumptions about the nature of this duality. This creates a problem of experimental identification of preferences since without such assumptions it is impossible to distinguish whether consumption or social concerns are driving the behavior. Given observed choice, the axiomatic model of preferences in this paper makes it possible to unambiguously determine personal and social utility without any assumptions about their relationship. The unique separation can be achieved only if the individual choices in different subgroups of other people are available. Preferences over consumption and status are used as an example to demonstrate how the utility is constructed. The model shows what kind of information about choice is needed to experimentally determine the nature of social preferences without making restrictive assumptions. This can help to estimate whether personal consumption or social value is more important in economic decisions.

JEL classification: D01, D11, C90.
Keywords: axiomatic systems, experiments, social preferences, status, subjective probability.

---

*I would like to thank Aldo Rustichini, Marcel K. Richter, and Michele Boldrin for innumerable conversations and guidance that shaped my comprehension of the subject and resulted in this paper. I am grateful to Andrew Cassey, Joshua Miller and the participants of the Neuroeconomics workshop at the University of Minnesota for insightful comments. All mistakes are mine.
Correspondence: Department of Economics, P.O. Box 616, Maastricht 6200 MD, The Netherlands
e-mail: a.vostroknutov@algec.unimaas.nl

1 Introduction

It is a well established fact that people have strong tendency to compare themselves with their social group. Deviations from rationality due to distributional concerns were found in many experimental settings: markets (Ball, Eckel, Grossman, and Zame, 2001); public goods (Andreoni, 1995; Fehr and Gächter, 2000); Ultimatum games (Costa-Gomes and Zauner, 2001). One way to rationalize the behavior in these experiments is to assume that utility is a function of the payoffs of others. This modeling technique was used in several studies: inequality aversion (Fehr and Schmidt, 1999); equity, reciprocity and competition (Bolton and Ockenfels, 2000); altruism and spitefulness (Levine, 1998); status-seeking (Frank, 1985). The goal of this avenue of research is to find social utility that explains the behavior in as many settings as possible. The following principle is generally used. An assumption is made about the nature of interdependence in preferences, for example, inequality aversion, status-seeking, or altruism; some parametric functional form is proposed and the estimates of its parameters are found from the data.

There are several difficulties with this approach. First, the behavior in many experiments can be consistent with different assumptions on the nature of interdependence. For example, proposing non-zero amount in the Dictator game can be explained by inequality aversion, altruism, or even status-seeking.[1] Likewise, the behavior in the Ultimatum game can be explained by any of the three models. Second, it is impossible to pin down *relative importance* of personal and social utility in the environments where personal and social incentives are aligned. For example, people's preference of big cars over small ones can have very different driving force: it can be simply personal preference; it can be an attempt to "catch up with the Jonses"; or it can be the desire for less inequality (given that your car is smaller than average). Third, the models cited above are normally tested in experiments that involve games, thus confounding the effects of interdependence with intentionality (McCabe, Rigdon, and Smith, 2003) which plays important role in game theoretic settings (Dufwenberg and Kirchsteiger, 2004; Falk and Fischbacher, 2006).

The problems mentioned above make it hard to conclude what is the true nature of interdependence in preferences and how to determine it unambiguously from the observed choice. There are many reasons why knowing this is important. For example, if we discovered that people are more inequality averse than status seeking, then government policies directed at more equal wealth distribution can increase social welfare. However, if the reverse is true, such policy can lead to inefficiency as people might allocate resources away from consumption and towards status competition. If status-seeking is prevalent then taxing consumption might be Pareto improving as it will decrease excessive spending on status goods (Layard, 1980). Another empirical question is How big is social utility comparing to the personal one? For example, it is clear that in many environments people spend resources on status competitions. If status is relatively unimportant, then policies to reduce overconsumption might not be necessary. If the opposite is true, as argued in classical studies of Smith (1759) and Veblen (1899),

[1] Cummins (2005) discusses the evidence of high-status individuals proposing "gifts" or "protection" to low-status ones without expecting anything in return.

then government can increase welfare by eliminating the incentives to be involved in status seeking.[2] The knowledge of the structure of interdependence in preferences is important in different areas of economic research, for example, it can suggest better policies for designing incentives inside the firm (Auriol and Renault, 2008); bring better understanding of international economic migration (Massey et al., 1993).; or help explain consumption patterns (Charles, Hurst, and Roussanov, 2008).

This paper is an attempt to develop a theoretical framework that makes it possible to uncover social preferences from the observed choices. I show that if preferences are consistent with certain axioms, then, in the equivalent utility representation, the shape of social utility as well as its size relative to the personal utility can be determined unambiguously. In order to achieve this unique identification I assume that the choices of the same person are observed in more than one social group. The difference in preferences between groups is then used to determine the utility.

My search for the axiomatic systems and equivalent representations was guided by the desire to have simple testable axioms and tractable utility that can be used in further research. The framework suggests experimental designs, that can be used to test hypotheses about the properties of social utility. This makes it possible to find out the nature of interdependence without using parametric assumptions on the shape of the utility and without confounding it with intentionality.

There are no assumptions in the model that limit the possible shape of social utility in any way. However, I use status seeking to illustrate how the model works. There are several reasons for this. First, the desire for both status and consumption drive the behavior in the same direction, thus making it most challenging to separate their effects. Second, growing body of literature supports the hypothesis that envy and the resulting desire for status are evolved traits of humans beings (Cummins, 2005). Economic experiments also confirm this (Rustichini and Vostroknutov, 2006, 2007).

The paper is organized as follows. In section 2 I use examples to discuss conceptual problems with separability of social and personal parts of the preferences. Section 3 starts with the description of the framework and the issue of how to model uncertainty. In sections 4 and 5 the models with single and multiple priors are described. Section 6 concludes with suggestions of experimental designs. Proofs of the theorems and lemmata can be found in parts 7 and 8. Section 9 contains notation.

2 Separability of Consumption and Status

People choose to buy some goods purely for consumption purposes, for example cheap food. Other goods are bought for status reasons.[3] However, most goods are chosen for both reasons at once. A good example is cars. People like cars because they are convenient. However, it can hardly be denied that certain cars are produced and bought for status reasons as well.

[2] See De Graaf, Wann, and Naylor (2005) for a variety of anecdotal examples of overconsumption.

[3] It is hard to come up with an example of pure status good, as most status goods, like antique cars or art, can be resold, making the reasons for their demand unclear.

In order to model social preferences, it is, thus, important to have consumption and social parts of the utility intertwined. How should these parts be represented? The consumption part of the preferences should be independent of anything related to others. It should depend only on the possessions x_0 of an agent. Let us denote consumption part of the utility by $U_c(x_0)$. Status preferences should depend on what others have as well as on the possessions of the agent. I assume that people care about others' possessions only relatively to their own. This implies that status utility should be represented by a function $U_s(x_0, others)$, where *others* is, say, distribution of possessions of others. $U_s(x_0, others)$ should not be additively separable in its arguments for otherwise we are back to the case of non-relative status. Independence of consumption then implies the following utility:

$$U(x_0, others) = U_c(x_0) + U_s(x_0, others).$$

It is important that U_c and U_s are summed here, for otherwise we cannot talk about consumption utility at all. In case $U(x_0, others) = f(U_c(x_0), U_s(x_0, others))$ we cannot say how much personal satisfaction x_0 brings to the agent since it always depends on the others.

Here is a problem. Choose any function $g(x_0)$ and redefine the utility as

$$U(x_0, others) = g(x_0) + \bar{U}_s(x_0, others)$$

where $\bar{U}_s(x_0, others) = U_s(x_0, others) + U_c(x_0) - g(x_0)$. It is clear that $\bar{U}_s$ is still not additively separable. But then any function g can be the utility for consumption! This shows that it is impossible *in principle* to separate status from consumption in a unique way when we observe individual choices that conform with utility U.

One way around this is to assume that we can observe the choices of the agent inside different social groups as well as between the groups. Consider preferences of a game theorist over the number of publications in top economics journals and two social groups: "economists" and "biologists". Assume that the game theorist cares *differently* about these groups. This means that there are distributions of possessions of others such that she is *not* indifferent to which group to belong (with some fixed personal number of publications).

If game theorist reveals that she prefers to have more publications than everybody else while being among economists and she does not care about the number of publications while being among biologists (regardless of their publications in top economics journals), then we can conclude that she does not derive any personal utility from the number of publications, but only uses it to compare herself with other economists. Other way round, if she reveals *the same* preferences over the number of publications in both groups, then we conclude that she personally enjoys having more publications.[4] Such comparisons of preferences inside different social groups therefore uncover the shape of social utility. In the first example, it is clear that number of publications is used for status competition among economists and in the second, social utility is absent.

Another important piece of information about preferences can be elicited from the choices between groups. Imagine that game theorist reveals that as long as all economists

[4] This is where the assumption that she cares differently about two groups is pivotal.

and biologists do not have any publications, she does not care to which group to belong. This means that for the specific distribution of publications of others (nobody has any) game theorist chooses as if groups do not exist. Therefore, positive answer to the question “Do you prefer to have 5 to 0 publications given that no one else has any?” reveals her personal preference for having more publications.

I show that it is possible to construct unique utility[5] as long as the comparisons like the above can be made. In the example, preferences can be represented by two functions: $U_1(x_0, others) = U_c(x_0) + U_{s1}(x_0, others)$ and $U_2(x_0, others) = U_c(x_0) + U_{s2}(x_0, others)$ which correspond to the two groups. Notice that the personal utility U_c is group independent. The pivotal assumptions that are necessary for this result are: 1) preferences are observed inside different groups and between them; 2) there are distributions of possessions of others such that the agent *cares* to which group to belong; 3) there are distributions of possessions of others such that the agent *does not care* to which group to belong.

2.1 Group Size Matters

In this subsection I discuss why second assumption from the previous paragraph is so important for the result. In many theoretical and empirical papers which include social preferences (Bolton and Ockenfels, 2000; Luttmer, 2005) it is assumed that agents care about their own possessions and the mean of the distribution of the possessions of others. This assumption has an undesirable implication: the size of the group to which the agent compares herself becomes irrelevant. There are at least two reasons why this property is unappealing.

The first reason is that larger groups of people will most likely have more diverse distribution of skills. Thus, being average among some big group of others should *not* be indifferent to being average among the group’s subset. Suppose that the game theorist from the previous example has average number of publications among people on her department (which is, say, ranked 100). It seems very plausible that when asked a question Do you prefer to have average number of top publications among people on your department or average number of top publications among all economists? she would opt for the latter. Another setup where this effect is important is parading one’s possessions. Overconsumption of *visible* goods (Charles, Hurst, and Roussanov, 2008) is a straightforward example of trying to increase the size of the comparison group.

The second reason is that if the agent cares only about the mean of others’ possessions it is impossible to separate consumption from status for the reasons described in the beginning of this section. Given fixed possession of the agent and the distribution of possessions of others, the agent is indifferent which group to belong to. This removes the leverage that allows to uniquely separate consumption and status. Ok and Koçkesen (2000) study similar agent who has preferences over her possessions and the distribution of possessions of others (though without considering different social groups). They describe the axioms on preferences that give rise to the negatively interdependent

[5] Up to a positive affine transformation.

preferences that depend only on the possessions of the agent and the mean of the distribution. The authors overcome the unidentifiability problem by assuming that personal consumption is linear in the amount of goods and interdependence in preferences is negative (status). In my approach, the possibility of comparison between groups makes it possible to have arbitrary interdependence and consumption parts of the utility function.

3 The Framework

The world consists of agent 0 and a finite set S of other agents with $|S| > 1$ and $\{0\} \notin S$. We are interested in modeling the preferences of agent 0. Agent 0 has the measure of possessions *and* social status $x_0 \in X$, where X is any non-empty set. This measure can be some aggregate that is calculated using the possessions or some qualities of the agent, depending on the social group of interest. For example, it can be the money value of all the goods that the agent has ($X = \mathbb{R}_+$), or it can be the possessions themselves ($X = \mathbb{R}^n_+$).[6] The crucial assumption is that x_0 plays dual role of bringing not only consumption but also social benefit.

Think of S as a "big" set of all people that agent 0 can possibly care about. This can be, for example, people of the same profession, like all economists, or any other big social group. It is realistic to assume that at any given time agent 0 does not take into consideration everybody in S, but only some subset $T \subseteq S$. This subset can be, for example, the people that are geographically close to agent 0 (economists on the same economics department). An intuition behind this assumption might be like this: everybody in T observes the possessions (social status) of agent 0, because they are close to him and everybody else in $S \backslash T$ does not directly see agent 0's possessions (status); agent 0 does not take into account the people who do not see his possessions, but can potentially do so if they become aware of them (for example, if agent 0 moves to different city, or another economics department).

The final assumption that I am making is that agent 0 thinks of others as having some possessions (status) themselves. In particular, he has *priors*, or distributions over possessions of others in set X and can express preferences over his $x_0 \in X$ and priors over statuses of others in a given subgroup. In addition, I assume that agent 0 can report to which of the two groups of others he would like to belong, given proposed levels of his status and the priors over possessions of others in both groups.

In the following two sections I explore two different ways in which agent 0 can see the priors. One possibility is that for any group $T \in S$ agent 0 thinks that the possessions of each individual in T comes from single distribution (Section 4). Another possibility is that agent 0 has separate prior for each individual agent in T (Section 5). The goal for both cases is to find a simple utility representation and the set of simple axioms equivalent to this representation that would allow for an intuitive way of separating consumption and status preferences.

[6] The set X can by *any* set. Analogy with reals is brought only for illustration.

4 The Model with Single Prior

Assume that there are two subgroups of others S_1 and S_2. Suppose that agent 0 does not distinguish individual agents inside both subgroups, but rather treats the groups as entities in their own right. For example, the groups might be "economists" and "biologists". There are no assumptions on how these groups are related, in particular nothing is assumed about whether there are agents who belong to both groups. This information is not taken into account.[7] We observe preferences of agent 0 over two separate sets $\Delta(X^2)$ of simple lotteries[8] over X^2. The two copies of $\Delta(X^2)$ represent agent 0's possessions and his beliefs about others in two groups S_1 and S_2. For any fixed group and lottery, the first component of X^2 represents the status of agent 0. The conditional distribution of second component, *given any* x_0 *of agent 0*, represents agent 0's belief about possible statuses of all other agents in S_1 and S_2. I assume that agent 0 might not know his own status, but he knows the probabilities of realizations of his status and the beliefs over others' status levels, given those realizations. Let us assume that we observe agent 0's preferences over all possible combinations of his status and his beliefs $\mathcal{E}_{S_1} = \mathcal{E}_{S_2} := \Delta(X^2)$ in both groups of others. Let

$$\mathcal{E} := \mathcal{E}_{S_1} \cup \mathcal{E}_{S_2}$$

be the set of all possible lotteries over agent 0's status and beliefs about others in both groups and let $\succcurlyeq$ be a preference relation over $\mathcal{E}$ with $\sim$ and $\succ$ being its symmetric and asymmetric parts.

The following notation will be used in this section. Let $\mathcal{S} = \{S_1, S_2\}$ be a two element set. For $T \in \mathcal{S}$ write $(x_0, \eta)_T \in \mathcal{E}_T$ as an element of $\Delta(X^2)$ such that the status of agent 0 is fixed at x_0 and his beliefs about others in T are $\eta \in \Delta(X)$. The expectation of a function with two arguments is written as $E_h[v(x_0, x)]$ for $h \in \Delta(X^2)$, or as $E_\eta[v(x_0, \cdot)]$ for $\eta \in \Delta(X)$, with first argument fixed.

4.1 Separation of Consumption and Status

In this section the minimal number of axioms that allows for the intuitive separation of consumption from status is given. The first set of axioms are the standard conditions necessary to obtain expected utility representation for the preferences.

E1 $\succcurlyeq$ is reflexive, transitive, total,[9] and non-trivial:

- **1.1** For all $T \in \mathcal{S}$ there are $x_0 \in X$ and $\eta, \nu \in \Delta(X)$ such that $(x_0, \eta)_T \succ (x_0, \nu)_T$
- **1.2** There are $x_0^* \in X$ and $\eta^* \in \Delta(X)$ such that $(x_0^*, \eta^*)_{S_1} \succ (x_0^*, \eta^*)_{S_2}$

[7]See Section 5 for the model with multiple priors

[8]Simple lotteries are those with finite support.

[9]Totality: $a \neq b \Rightarrow [a \succcurlyeq b \vee b \succcurlyeq a]$.

E2 *Independence.* For all $T \in \mathcal{S}$, all $h, z, w \in \mathcal{E}_T$ and all $\alpha \in (0, 1)$

$$h \succ z \implies \alpha h + (1-\alpha)w \succ \alpha z + (1-\alpha)w$$

E3 *Continuity.* For all $T \in \mathcal{S}$, all $h, z, w \in \mathcal{E}_T$ there exist $\alpha, \beta \in (0, 1)$

$$h \succ z \succ w \implies \alpha h + (1-\alpha)w \succ z \succ \beta h + (1-\beta)w$$

Apart from the standard weak order assumptions, axiom $E1$ requires that $\succcurlyeq$ is non-trivial in two different ways: E1.1 asks for agent 0 to care about what others have as well; E1.2 asks for the existence of a pair (x_0^*, η^*) such that agent 0, given the choice between two groups, prefers being in group S_1 rather than S_2 with the same level of his possessions and beliefs about others. Throughout the exposition the asymmetry between S_1 and S_2 will be maintained: agent 0 will be assumed to care more about S_1.

Axioms E2 and E3 are standard requirements for $\succcurlyeq$ to have expected utility representation. Notice that these axioms restrict $\succcurlyeq$ only inside each fixed group and they say nothing about the choices between groups.

The next two axioms are the minimal conditions that allow for the intuitively sensible way to disentangle consumption part of the preferences from the status part (or any other type of interdependency). The main idea is to fix agent 0's possessions $x_0 \in X$ and his beliefs about others $\eta \in \Delta(X)$ and see how he chooses between the two groups. There are two possibilities: 1) agent 0 prefers one group to the other: $(x_0, \eta)_{S_1} \succ (x_0, \eta)_{S_2}$; 2) agent 0 is indifferent: $(x_0, \eta)_{S_1} \sim (x_0, \eta)_{S_2}$. In the former case, since everything but the group identity is fixed, agent 0's choice must have been influenced only by the properties of the groups. In the latter case there are two possible explanations: agent 0 is indifferent, because he does not care at all to which group to belong (which is ruled out by E1.2); or he *does* care about the groups, but is indifferent in this particular case because of some property of the prior η (for example, as long as everybody has the same amount as agent 0, he does not care which group to be with). This last possibility gives us the way to reveal the consumption part of agent 0's preferences. Suppose that we somehow established that agent 0 is indifferent between $(x_0, \eta)_{S_1}$ and $(x_0, \eta)_{S_2}$ because of some property of η and that the same holds for some $(y_0, \nu)_{S_1}$ and $(y_0, \nu)_{S_2}$. For these two pairs the effects of differences between groups are offset by the special properties of η and ν. Therefore, agent 0's preferences over $(x_0, \eta)_{S_1}$ and $(y_0, \nu)_{S_1}$ are influenced only by the consumption benefits of x_0 and y_0. The following axioms make sure that comparisons like this can be made.

E4 *Group Indifference.*

4.1 For all $x_0 \in X$ there is $x^* \in X$ such that $(x_0, x^*)_{S_1} \sim (x_0, x^*)_{S_2}$

4.2 For any $\ell, m \in \Delta(X^2)$ and $\alpha \in [0, 1]$

$$[\ell_{S_1} \sim \ell_{S_2} \quad \wedge \quad m_{S_1} \sim m_{S_2}] \implies (\alpha\ell + (1-\alpha)m)_{S_1} \sim (\alpha\ell + (1-\alpha)m)_{S_2}$$

Axiom E4.1 requires that for any x_0 we can find some special belief about others $x^* \in X$ such that agent 0 is indifferent between the groups. If such element does not exist for some x_0, then we cannot use the procedure described above to separate the consumption effect. Indeed, suppose that for any $\eta \in \Delta(X)$ we have strong preference between $(x_0, \eta)_{S_1}$ and $(x_0, \eta)_{S_2}$. Assume that $\succcurlyeq$ can be represented by some utility function. Then, the utilities of $(x_0, \eta)_{S_1}$ and $(x_0, \eta)_{S_2}$ have to depend on some properties of the groups all the time, thus making it impossible to disentangle the consumption part. E4.2 asks for some consistency when the mixtures of indifferent pairs are considered. Given two indifferent pairs, the same mixture of them in both groups keeps agent 0 indifferent.

E5 *Group Disparity.*[10] For all $x_0 \in X$ and $\eta, \nu \in \Delta(X)$ with $(x_0, \eta)_{S_1} \sim (x_0, \eta)_{S_2}$

$$\begin{aligned} (x_0, \nu)_{S_2} \succ (x_0, \eta)_{S_2} \quad &\Longrightarrow \quad (x_0, \nu)_{S_1} \succ (x_0, \nu)_{S_2} \quad \text{and} \\ (x_0, \eta)_{S_2} \succ (x_0, \nu)_{S_2} \quad &\Longrightarrow \quad (x_0, \nu)_{S_2} \succ (x_0, \nu)_{S_1} \end{aligned}$$

Axiom E5 establishes the way in which agent 0 can care differently about the two groups. It says that agent 0 *always cares more* about S_1 than about S_2: for any indifferent pair $(x_0, \eta)_{S_1} \sim (x_0, \eta)_{S_2}$, if agent 0 prefers some (x_0, ν) in S_2 to (x_0, η) in S_2 then he should like it even more in S_1 and vice versa. To illustrate the intuition think of the groups of economists and biologists. An economist would value his academic success higher if other economists know about it rather than when biologists know about it and other way round: he would be more unhappy if other economists get aware of his academic misfortune than when biologists find out about it. This axiom essentially establishes the desired property of the indifference pairs $(x_0, \eta)_{S_1} \sim (x_0, \eta)_{S_2}$: agent 0 always prefers S_1 to S_2, the indifference between the groups can result only from the special properties of the beliefs η.

The following definitions and the Theorem give the utility representation for the preferences that satisfy the above axioms.

Definition 1. *Call any $v : X^2 \to \mathbb{R}$ a* ***status function*** *if it is not constant and there is an $x^*(x_0) \in X$ such that $v(x_0, x^*(x_0)) = 0$ for all $x_0 \in X$.*

Definition 2. *Let $g : X \to \mathbb{R}$ be any function, and $v_{S_1}, v_{S_2} : X^2 \to \mathbb{R}$ be status functions such that for any $x_0, x \in X$ and $\eta \in \Delta(X)$*

$$v_{S_1}(x_0, x) = v_{S_2}(x_0, x) \iff v_{S_1}(x_0, x) = 0 \tag{4.1}$$

$$\frac{E_\eta[v_{S_2}(x_0, \cdot)]}{E_\eta[v_{S_1}(x_0, \cdot)]} \in (0, 1) \quad \Longleftarrow \quad E_\eta[v_{S_2}(x_0, \cdot)] \neq 0 \tag{4.2}$$

For $T \in \mathcal{S}$ let $V_T : \mathcal{E}_T \to \mathbb{R}$ be defined as

$$V_T[h] = E_h[g(x_0) + v_T(x_0, x)].$$

Finally, let $V : \mathcal{E} \to \mathbb{R}$ be equal to $V_T[h]$ for all $T \in \mathcal{S}$ and $h \in \mathcal{E}_T$.

[10] This axiom and E5* below assume asymmetry between S_1 and S_2. The axioms could have asked for one of the two groups to play the role of S_1. This can be done by switching the names of the groups instead.

Theorem 1. *The following two statements are equivalent*

1. $\succcurlyeq$ *satisfies E1-E5*

2. $\succcurlyeq$ *has a utility representation* $V : \mathcal{E} \to \mathbb{R}$ *as described in Definition 2, unique up to a positive affine transformation.*

Proof. See Section 7.

In the utility representation $g(x_0) + v_T(x_0, x)$, the first part is consumption part of the utility and the second part represents the social part. The functions v_{S_1} and v_{S_2} satisfy two properties: 1) they are equal to zero only when agent 0 does not care about the two groups; 2) whenever they are not zero (there are some group effects) they are different. This reflects the ideas about the separation of consumption described above. In particular, it is never the case that v_{S_1} and v_{S_2} are equal and not zero. This case is not desirable because it is not clear then whether it is consumption or social utility that drives agent 0's preference.

4.2 Linear Group Disparity

One drawback of the above formulation is the condition 4.2. There is no simple way to check if some functions v_{S_1} and v_{S_2} satisfy it unless certain linearity conditions hold. For example, 4.2 is satisfied if $v_{S_2}(x_0, x) = \pi(x_0) v_{S_1}(x_0, x)$ for some positive number $\pi(x_0)$. In this subsection I give an additional axiom that is necessary and sufficient for such representation. Additional benefit is that this utility representation has less parameters. The main change comes in having only one social utility function v that represents the social part of the utility in both groups. The difference between the groups comes from different weighting of the function v.

The first case deals with the addition of one more axiom to the five axioms presented above. This axiom does not require anything particularly strong, but, amazingly, allows for much more specific functional representation of preferences.

E6 *Likes and Dislikes.* For any $T \in \mathcal{S}$, $x_0 \in X$ and $\eta \in \Delta(X)$ with $(x_0, \eta)_{S_1} \sim (x_0, \eta)_{S_2}$

$$\begin{array}{llll} \text{either} & \forall \nu \in \Delta(X) & (x_0, \nu)_T & \sim & (x_0, \eta)_T \\ \text{or} & \exists \nu, \tilde{\nu} \in \Delta(X) & (x_0, \nu)_T & \succ & (x_0, \eta)_T \succ (x_0, \tilde{\nu})_T \end{array}$$

The axiom requires that for each $x_0 \in X$ only one of the two situations is possible: 1) agent 0 is indifferent between any beliefs about others, given x_0 or 2) there are beliefs that make agent 0 both happier and unhappier in both S_1 and S_2 than his consumption level. Essentially this rules out two unlikely cases when agent 0 just likes others to be around or hates others to be around (again, in comparison to his consumption level, that is represented by the indifference pair).

The following Definition and Theorem give the new representation.

Definition 3. *Let $g : X \to \mathbb{R}$ be any function, $v : X^2 \to \mathbb{R}$ be status function such that for all $x_0 \in X$ either $v(x_0, \cdot) \equiv 0$ or there are $x, x' \in X$ with $v(x_0, x)/v(x_0, x') < 0$, and let $\pi : X \to \mathbb{R}$ satisfy $\pi(x_0) \in (0, 1)$ for all x_0. For $T \in \mathcal{S}$ let $V_T : \mathcal{E}_T \to \mathbb{R}$ be defined as*

$$\begin{aligned} V_{S_1}[h] &= E_h[g(x_0) + v(x_0, x)] \\ V_{S_2}[h] &= E_h[g(x_0) + \pi(x_0)v(x_0, x)] \end{aligned} \tag{4.3}$$

Finally, let $V : \mathcal{E} \to \mathbb{R}$ be equal to $V_T[h]$ for all $T \in \mathcal{S}$ and $h \in \mathcal{E}_T$.

Theorem 2. *The following two statements are equivalent*

1. *$\succcurlyeq$ satisfies E1-E6*
2. *$\succcurlyeq$ has a utility representation $V : \mathcal{E} \to \mathbb{R}$ as described in Definition 3, unique up to a positive affine transformation.*

Proof. See Section 7.

In this new representation there is only one social utility function $v(x_0, x)$. For the group S_2 there is also a weighting function $\pi : X \to \mathbb{R}$ that tells how much less does agent 0 care about S_2 than S_1 for each x_0.

The last axiom in this section is an attempt to restrict the number of parameters in utility function even further. This new axiom is, however, somewhat strong.

E5* *Linear Group Disparity.* There is $\pi \in (0, 1)$ such that for all $x_0 \in X$ and $\eta, \nu \in \Delta(X)$

$$(x_0, \eta)_{S_1} \sim (x_0, \eta)_{S_2} \implies (\pi(x_0, \nu) + (1 - \pi)(x_0, \eta))_{S_1} \sim (x_0, \nu)_{S_2}$$

E5* requires that there is some fixed probability π such that agent 0 is indifferent between having any possessions and beliefs in S_2 and having the same pair in S_1 with probability π. In terms of the weighting of the social part of the utility this means that the weight is always the same. Whether this assumption is reasonable or not can be determined experimentally. The following Definition and Theorem give the representation for this case.

Definition 4. *Let $g : X \to \mathbb{R}$ be any function, $v : X^2 \to \mathbb{R}$ be status function, and let $\pi \in (0, 1)$. For $T \in \mathcal{S}$ let $V_T : \mathcal{E}_T \to \mathbb{R}$ be defined as*

$$\begin{aligned} V_{S_1}[h] &= E_h[g(x_0) + v(x_0, x)] \\ V_{S_2}[h] &= E_h[g(x_0) + \pi v(x_0, x)] \end{aligned} \tag{4.4}$$

Finally, let $V : \mathcal{E} \to \mathbb{R}$ be equal to $V_T[h]$ for all $T \in \mathcal{S}$ and $h \in \mathcal{E}_T$.

Theorem 3. *The following two statements are equivalent*

1. *$\succcurlyeq$ satisfies E1-E4, E5**
2. *$\succcurlyeq$ has a utility representation $V : \mathcal{E} \to \mathbb{R}$ as described in Definition 4, unique up to a positive affine transformation.*

Proof. See Section 7.

5 The Model with Multiple Priors

In this section I assume that agent 0 has separate prior for each individual in each group of others. The important difference from the previous section comes from the possibility for other agents to belong to several subgroups simultaneously. I use Anscombe and Aumann (1963) framework to construct preferences that are represented by unique[11] expected utility function that is given by

$$U(x_0, x_1, ..., x_T) = f(x_0) + \sum_{i \in T} \pi_i u(x_0, x_i)$$

when restricted to the degenerate distributions over $(x_i)_{i \in T}$. Here x_0 is a measure of possessions of agent 0, whose preferences are studied. $(x_i)_{i \in T}$ are the same measures for other agents in subgroup T of some set S of all possible others. Agent 0 cares about two things. First, x_0 has some consumption value. Second, agent 0 derives social value from x_0 by comparing it to what others have. The consumption part of the utility is represented by $f(x_0)$ whereas the status part is the weighted sum over others. The function $u(x_0, x)$ describes the specific way agent 0 cares about his position relative to one other person and $(\pi_i)_{i \in T}$ are the weights that represent the importance or "closeness" of each other individual to agent 0.

Notice that the desired utility form U in case of multiple priors, when restricted to the single prior case (all others have the same distribution over possessions), corresponds to the result of Theorem 3, which was obtained with very strong axiom E5*. Below I show that it is possible to obtain representation U without anything like E5*.

In order to obtain uniqueness of this representation it is necessary that the preferences of agent 0 are observed in different subgroups of others. Moreover, in order to obtain unique weights $(\pi_i)_{i \in S}$ for each agent in S and unique function u it is necessary that the observed subgroups have certain degree of intersection. In case of disjoint subgroups it is impossible to pin down unique function u.

The following definition puts the constraints on the observable subgroups.

Definition 5. *Say that the collection of observed subgroups $\mathcal{C} \subseteq 2^S$ is **connected** if $\{\emptyset\} \notin \mathcal{C}$, $|\mathcal{C}| > 1$, $\cup \mathcal{C} = S$, and for all $T, R \in \mathcal{C}$ there exist $C_1, ..., C_K \in \mathcal{C}$ such that*

$$T \cap C_1 \neq \emptyset, \quad C_k \cap C_{k+1} \neq \emptyset, \quad C_K \cap R \neq \emptyset \qquad \text{where } k = 1..K-1.$$

The first three requirements say that 1) we do not observe the behavior of agent 0 in complete solitude (the presence of observer himself makes it impossible); 2) there is more than one subgroup (for otherwise we cannot uniquely separate status and consumption); 3) subgroups cover all other agents (if not, then remove unobserved agents from S) and 4) any two subgroups can be "connected" by the sequence of intersecting subgroups (otherwise we would have "disconnected" collections of subgroups again making unique identification impossible, see section 2).

[11]Up to a positive affine transformation

Next, let us define for each subgroup $T \subseteq S$ the set of outcomes about which agent 0 cares, or has preferences. It is natural to consider

$$\mathcal{X}_T := \Delta(X^{\{0\}\cup T})$$

the set of all simple lotteries over the statuses of agent 0 and all other agents in subgroup T.

Choose any connected collection $\mathcal{C} \subseteq 2^S$ of subgroups (see Definition 5) and let

$$\mathcal{A} := \bigcup_{T\in\mathcal{C}} \mathcal{X}_T$$

be the set of all lotteries in $\mathcal{X}_T$ in all available subsets of other agents. Consider preference relation $\dot{\succcurlyeq}$ over $\mathcal{A}$ with $\dot{\sim}$ and $\dot{\succ}$ being its symmetric and asymmetric parts.

Define a mixture of two lotteries $h, z \in \mathcal{X}_T$ with the same domain T to be standard lottery mixture. This turns $\mathcal{X}_T$ into a mixture set as defined in Herstein and Milnor (1953).

The following notation is used in the description of the axioms below (see also Section 9). For $h \in \mathcal{X}_T$ or $p \in \Delta(X^T)$, $\mu_i(h)$ (or $\mu_i(p)$) stands for the ith marginal distribution. $\Pi\mu_i(p) \in \Delta(X^T)$ is the distribution obtained from $p \in \Delta(X^T)$ by taking all marginals and treating them as independent.

Suppose that the following axioms hold:

A0 *Self-Comparison.* For all $T \in \mathcal{C}$, all $x_0 \in X$ and all $p \in \Delta(X^T)$

$$(x_0, p)_T \;\dot{\sim}\; (x_0, \Pi\mu_i(p))_T$$

A1 $\dot{\succcurlyeq}$ is reflexive, transitive, total, and non-trivial: for any $T \in \mathcal{C}$ there are $x_0, x, x' \in X$ such that

$$(x_0, x)_T \;\dot{\succ}\; (x_0, x')_T$$

A2 *Independence.* For all $T \in \mathcal{C}$, all $h, z, w \in \mathcal{X}_T$ and all $\alpha \in (0, 1)$

$$h \;\dot{\succ}\; z \;\Rightarrow\; \alpha h + (1-\alpha)w \;\dot{\succ}\; \alpha z + (1-\alpha)w$$

A3 *Continuity.* For all $T \in \mathcal{C}$, all $h, z, w \in \mathcal{X}_T$ there exist $\alpha, \beta \in (0, 1)$

$$h \;\dot{\succ}\; z \;\dot{\succ}\; w \;\Rightarrow\; \alpha h + (1-\alpha)w \;\dot{\succ}\; z \;\dot{\succ}\; \beta h + (1-\beta)w$$

A4 *Anonymity.* For all $T \in \mathcal{C}$, $\mathbf{x} \in X^T$, $i, j \in T$, and $\ell, m \in \Delta(X^2)$

$$(\ell, \mathbf{x}_{-i})_T \;\dot{\succcurlyeq}\; (m, \mathbf{x}_{-i})_T \iff (\ell, \mathbf{x}_{-j})_T \;\dot{\succcurlyeq}\; (m, \mathbf{x}_{-j})_T$$

A5 *Unimportance.* For all $x_0 \in X$ there exists $x^*(x_0) \in X$ such that for all intersecting $T, R \in \mathcal{C}$, all $Q \subseteq T \cap R$ and all $x \in X$

$$(x_0, (x^*(x_0))_{T\setminus Q}, (x)_Q) \;\dot{\sim}\; (x_0, (x^*(x_0))_{R\setminus Q}, (x)_Q)$$

A6 *Group Disparity.* There exist $S_1, S_2 \in \mathcal{C}$ such that for all $x_0, x, x' \in X$ with $(x_0, x)_{S_1} \dot{\sim} (x_0, x)_{S_2}$

$$\begin{array}{ccc} (x_0, x')_{S_1} \dot{\succ} (x_0, x)_{S_1} & \Rightarrow & (x_0, x')_{S_1} \dot{\succ} (x_0, x')_{S_2} \quad \text{and} \\ (x_0, x)_{S_1} \dot{\succ} (x_0, x')_{S_1} & \Rightarrow & (x_0, x')_{S_2} \dot{\succ} (x_0, x')_{S_1} \end{array}$$

***

Axioms A1-A3 are standard necessary conditions for existence of an expected utility representation for each $T \in \mathcal{C}$.

Axiom A4 says that agent 0 does not care about the names of the other agents. Given any fixed outcomes for all agents but i, if agent 0 prefers lottery ℓ to m then he will also prefer ℓ to m in a situation when he faces agent j instead of i with all other outcomes still being fixed. Together with the axioms above, A4 implies that in each restriction $\dot{\succcurlyeq}_T$ agent 0 treats all other agents in T in the same way. The only difference comes from the weights he attaches to different agents. These weights describe the relative "social" closeness of others to agent 0, whereas being in subgroup T incorporates the idea of "topological" closeness.

A4 puts restrictions on what can happen inside each subgroup T. The rest of the axioms deal with what happens between different subgroups. Without A5-A6 any two restrictions $\dot{\succcurlyeq}_T$ and $\dot{\succcurlyeq}_R$ are completely unrelated. It is desirable, however, that agent 0 choose somewhat consistently in different subgroups.

For each level of status x_0 of agent 0, axiom A5 asks for the existence of special status level $x^*(x_0)$ of any agent i, such that agent 0, when facing the outcome $(x_0, x^*(x_0))$, does not care about i and chooses as if i does not exist. For example, agent 0 might not care about others as long as they have no status or possessions at all ($x^*(x_0) = 0$), but he starts taking them into account once they have more than that.

Axiom A6 requires that there exist two subgroups $T, R \in \mathcal{C}$ to which agent 0 attaches different total social weight. In particular, if for some (x_0, x) it so happens that $(x_0, x)_T \dot{\sim} (x_0, x)_R$, then if agent 0 prefers having $(x_0, x')_T$ to $(x_0, x)_T$ then he prefers it also over $(x_0, x')_R$. This means that subgroup T is preferable to subgroup R only because agent 0 likes having agents T around more than agents R. A counterexample might be the situation when all subgroups in $\mathcal{C}$ have the same number of others and the same social weights are attached to all of them. In this case we will have $h_T \dot{\sim} h_R$ for all $h \in \mathcal{X}_T$ and any $T, R \in \mathcal{C}$, which leads to the indeterminacy of status component of the preferences. Axiom A6 is necessary when there are no two subgroups in $\mathcal{C}$ such that one is the strict subset of the other. If such subgroups exist, then A6 can be dropped without consequences.

Definition 6. *Let $f : X \to \mathbb{R}$ be any function, $u : X^2 \to \mathbb{R}$ be status function, and let $(\pi_i)_{i \in S}$ be positive numbers. For $T \in \mathcal{C}$ let $U_T : \mathcal{X}_T \to \mathbb{R}$ be defined as*

$$U_T[h] = E_h[f(x_0) + \sum_{i \in T} \pi_i u(x_0, x_i)]$$

Finally, let $U : \mathcal{A} \to \mathbb{R}$ be equal to $U_T[h]$ for all $T \in \mathcal{C}$ and $h \in \mathcal{X}_T$.

Theorem 4. *The following two statements are equivalent*

1. $\succcurlyeq$ *satisfies A0-A6*

2. $\succcurlyeq$ *has a utility representation* $U : \mathcal{A} \to \mathbb{R}$ *as described in Definition 6, unique up to a positive affine transformation.*

Proof. See Section 7.

6 Conclusion

The model of preferences constructed in this paper shows that it is possible to separate consumption preferences from social preferences. In order to do so one needs to observe the choices people make in different subgroups. This creates the possibility to experimentally find out what social preferences are without making ad hoc assumptions. The next step in this research is to design an experiment or find the data which would help to understand the relative importance of social and personal components of preferences. It is necessary to check whether the axioms proposed in this paper hold. Axioms E4-E6 can be tested in the lab by making subjects play some game of skill (as in Rustichini and Vostroknutov (2006), for example) and then eliciting their preferences over belonging to different subgroups of other participants. This can be done by, for example, asking subjects to what number of people in the group do they want their winnings in the game of skill to be revealed. Given their beliefs about the distribution of winnings of others subjects' the answers will reveal the shape of their social preferences.

7 Proofs

Proof of Theorem 1.

[**1** $\implies$ **2**] By Theorem 8.4 of Fishburn (1970) axioms E1-E3 together with mixture set structure on $\Delta(X^2)$ generated by compound lottery rule imply that for all $T \in \mathcal{S}$, preference relation $\succcurlyeq$ restricted to $\mathcal{E}_T$ has expected utility representation

$$h \succcurlyeq z \iff \bar{V}_T[h] \geq \bar{V}_T[z].$$

for some functions $\bar{V}_T$, fixed up to a positive affine transformation.

Let

$$X^* := \{(x_0, \eta) \in \Delta(X^2) : (x_0, \eta)_{S_1} \sim (x_0, \eta)_{S_2}\}$$

and consider the set $\Delta(X^*)$. By E4.1, $\Delta(X^*)$ contains elements of the form (x_0, x^*) for any $x_0 \in X$ and by E5, for all $x_0 \in X$, $T \in \mathcal{S}$ and all $(x_0, \eta), (x_0, \nu) \in \Delta(X^*)$, $(x_0, \eta)_T \sim (x_0, \nu)_T$. To see that the latter statement holds, suppose, by contradiction, that there are $(x_0, \eta), (x_0, \nu) \in \Delta(X^*)$ such that $(x_0, \nu)_{S_2} \succ (x_0, \eta)_{S_2}$. Then, E5 implies that $(x_0, \nu)_{S_1} \succ (x_0, \nu)_{S_2}$, which contradicts the assumption that $(x_0, \nu) \in \Delta(X^*)$.

The consequences of E4.1 and E5 imply that for any $T \in \mathcal{S}$ the restriction of $\bar{V}_T$ to $\Delta(X^*)$ can be written as

$$\bar{V}_T[h] = E_h[g_T(x_0)]$$

for some function $g_T : X \to \mathbb{R}$. By E4.2, for any $\ell \in \Delta(X^*)$ it is true that $\ell_{S_1} \sim \ell_{S_2}$, therefore, for any $\ell, m \in \Delta(X^*)$

$$\ell_{S_1} \succcurlyeq m_{S_1} \iff \ell_{S_2} \succcurlyeq m_{S_2}.$$

This means that the restriction of $\succcurlyeq$ to $\Delta(X^*)$, viewed as a subset of either $\mathcal{E}_{S_1}$ or $\mathcal{E}_{S_2}$, induces the order, independent of the group. $\Delta(X^*)$ is a mixture set with mixture structure inherited from $\Delta(X^2)$. In addition, properties E1-E3 transfer to $\Delta(X^*)$. Therefore, by Theorem 8.4 of Fishburn (1970), g_{S_1} and g_{S_2} are positive affine transformations of one another. This makes it possible to apply positive affine transformation to $\bar{V}_{S_2}$ obtaining V_{S_2} (which still represents $\succcurlyeq$ on $\mathcal{E}_{S_2}$) so that

$$\bar{V}_{S_1}[(x_0, \eta)_{S_1}] =: V_{S_1}[(x_0, \eta)_{S_1}] = V_{S_2}[(x_0, \eta)_{S_2}] =: g(x_0)$$

whenever $(x_0, \eta)_{S_1} \sim (x_0, \eta)_{S_2}$.

Let $v_T(x_0, x) := V_T(x_0, x) - g(x_0)$. We can rewrite $V_T(x_0, x) = g(x_0) + v_T(x_0, x)$. Condition (4.1) for functions v_T is satisfied since the set X^* contains all elements (x_0, x^*) for which agent 0 is indifferent between the two groups. Condition (4.2) follows from E5. ▲

[**2** $\implies$ **1**] E1-E3 follow from the only if part of Theorem 8.4 of Fishburn (1970). E4.1 is a consequence of v_{S_1} and v_{S_2} being status functions. E4.2 is obvious. E5 directly follows from the properties (4.1) and (4.2). ■

Proof of Theorem 2.

Theorem 1 shows that $\succcurlyeq$ can be represented by expected utility functions $V_T(x_0, x) = g(x_0) + v_T(x_0, x)$ where $v_T(x_0, x)$ are status functions satisfying Definition 2. By E6, for any $x_0 \in X$ either 1) $v_T(x_0, \cdot) \equiv 0$ or 2) there are $x, x' \in X$ with $v_T(x_0, x) > 0 > v_T(x_0, x')$. Consider any x_0 for which the latter holds. Let β^* be such that $\beta^* v_{S_2}(x_0, x) + (1 - \beta^*) v_{S_2}(x_0, x') = 0$. Then by E5

$$\begin{aligned} \beta \in [0, \beta^*) \quad &\Rightarrow \quad \beta v_{S_1}(x_0, x) + (1-\beta) v_{S_1}(x_0, x') < \beta v_{S_2}(x_0, x) + (1-\beta) v_{S_2}(x_0, x') < 0 \\ \beta \in (\beta^*, 1] \quad &\Rightarrow \quad \beta v_{S_1}(x_0, x) + (1-\beta) v_{S_1}(x_0, x') > \beta v_{S_2}(x_0, x) + (1-\beta) v_{S_2}(x_0, x') > 0 \end{aligned}$$

This implies that

$$\begin{aligned} \lim_{\beta \uparrow \beta^*} \beta v_{S_1}(x_0, x) + (1-\beta) v_{S_1}(x_0, x') \quad &\leq \quad 0 \\ \lim_{\beta \downarrow \beta^*} \beta v_{S_1}(x_0, x) + (1-\beta) v_{S_1}(x_0, x') \quad &\geq \quad 0. \end{aligned}$$

Since $\beta v_{S_1}(x_0, x) + (1 - \beta) v_{S_1}(x_0, x')$ is a continuous function of β, the only way both inequalities can hold is if $\beta^* v_{S_1}(x_0, x) + (1 - \beta^*) v_{S_1}(x_0, x') = 0$. This, together with analogous equality for v_{S_2} lets us conclude that

$$\frac{v_{S_2}(x_0, x')}{v_{S_1}(x_0, x')} = \frac{v_{S_2}(x_0, x)}{v_{S_1}(x_0, x)} =: \pi(x_0) \in (0, 1)$$

This definition of $\pi(x_0)$ is unambiguous since the above equality holds for any x and x' for which $v_T(x_0, x) > 0 > v_T(x_0, x')$. Therefore, $v_{S_1}(x_0, x) = \pi(x_0) v_{S_2}(x_0, x)$.

In the other case when $v_T(x_0, \cdot) \equiv 0$ set $\pi(x_0)$ to be any number between 0 and 1. ■

Proof of Theorem 3.

[**1** $\Longrightarrow$ **2**] By Theorem 8.4 of Fishburn (1970) axioms E1-E3 together with mixture set structure on $\Delta(X^2)$ generated by compound lottery rule imply that for all $T \in \mathcal{S}$, preference relation $\succcurlyeq$ restricted to $\mathcal{E}_T$ has expected utility representation

$$h \succcurlyeq z \quad \Longleftrightarrow \quad \bar{V}_T[h] \geq \bar{V}_T[z].$$

for some functions $\bar{V}_T$, fixed up to a positive affine transformation.

Let

$$X^* := \{(x_0, \eta) \in \Delta(X^2) : (x_0, \eta)_{S_1} \sim (x_0, \eta)_{S_2}\}$$

and consider the set $\Delta(X^*)$. By E4.1, $\Delta(X^*)$ contains elements of the form (x_0, x) for any $x_0 \in X$ and by E5*, for all $x_0 \in X$, $T \in \mathcal{S}$ and all $(x_0, \eta), (x_0, \nu) \in \Delta(X^*)$, $(x_0, \eta)_T \sim (x_0, \nu)_T$. To see that the latter statement holds, consider any $(x_0, \eta), (x_0, \nu) \in$

$\Delta(X^*)$. Then by E5* and the construction of $\Delta(X^*)$

$$(\pi(x_0,\eta)+(1-\pi)(x_0,\nu))_{S_1} \sim (x_0,\eta)_{S_2} \sim (x_0,\eta)_{S_1}.$$

This implies that $(x_0,\nu)_{S_1} \sim (x_0,\eta)_{S_1}$ since otherwise Independence axiom (E2) would be violated. $(x_0,\nu)_{S_2} \sim (x_0,\eta)_{S_2}$ now follows from the transitivity of $\sim$.

The consequences of E4.1 and E5* imply that for any $T \in \mathcal{S}$ the restriction of $\bar{V}_T$ to $\Delta(X^*)$ can be written as

$$\bar{V}_T[h] = E_h[g_T(x_0)]$$

for some function $g_T : X \to \mathbb{R}$. By E4.2, for any $\ell \in \Delta(X^*)$ it is true that $\ell_{S_1} \sim \ell_{S_2}$, therefore, for any $\ell, m \in \Delta(X^*)$

$$\ell_{S_1} \succcurlyeq m_{S_1} \iff \ell_{S_2} \succcurlyeq m_{S_2}.$$

This means that the restriction of $\succcurlyeq$ to $\Delta(X^*)$, viewed as a subset of either $\mathcal{E}_{S_1}$ or $\mathcal{E}_{S_2}$, induces the order independent of the group. $\Delta(X^*)$ is a mixture set with mixture structure inherited from $\Delta(X^2)$. In addition, properties E1-E3 transfer to $\Delta(X^*)$. Therefore, by Theorem 8.4 of Fishburn (1970), g_{S_1} and g_{S_2} are positive affine transformations of one another. This makes it possible to apply positive affine transformation to $\bar{V}_{S_2}$ obtaining V_{S_2} (which still represents $\succcurlyeq$ on $\mathcal{E}_{S_2}$) so that

$$\bar{V}_{S_1}[(x_0,\eta)_{S_1}] =: V_{S_1}[(x_0,\eta)_{S_1}] = V_{S_2}[(x_0,\eta)_{S_2}] =: g(x_0)$$

whenever $(x_0,\eta)_{S_1} \sim (x_0,\eta)_{S_2}$.

Let $v_T(x_0,x) := V_T(x_0,x) - g(x_0)$. We can rewrite $V_T(x_0,x) = g(x_0) + v_T(x_0,x)$. By E5 there exists $\pi \in (0,1)$ such that for all $x_0, x \in X$

$$\pi(g(x_0) + v_{S_1}(x_0,x)) + (1-\pi)g(x_0) = g(x_0) + v_{S_2}(x_0,x).$$

This implies $\pi v_{S_1}(x_0,x) = v_{S_2}(x_0,x) =: \pi v(x_0,x)$, shih is exactly the requirement of Definition 4. The functions v and πv are status functions by E4.1. ▲

[**2** $\implies$ **1**] E1-E3 follow from the only if part of Theorem 8.4 of Fishburn (1970). E4.1 is a consequence of v being status functions. E4.2 is obvious. E5* directly follows from the property (4.4). ■

Proof of Theorem 4.

[**1** $\implies$ **2**] The idea of the proof is to establish the existence of the weighted-additive utilities U_T for all $T \in \mathcal{C}$, then show that a unique function f can be constructed in a way that is consistent with each of the utility functions, and, finally, rescale the now redefined utility functions to show that all the utilities can have the specific form described in the Theorem.

1. Fix any $T \in \mathcal{C}$. Then A1-A3 and the fact that $\mathcal{X}_T$ is a mixture set imply the existence of the expected utility $U_T : \mathcal{X}_T \to \mathbb{R}$, unique up to a positive affine

transformation (Theorem 8.4 of Fishburn (1970)). Lemma 1 shows that U_T is the weighted-additive expected utility:

$$U_T[h] = \sum_{i \in T} \pi_T^i E_h[\bar{u}_T(x_0, x)]$$

where $\pi_T^i > 0$.

2. Lemma 3 says that for any x_0 there exists a non-empty set $X_{x_0}^*$ which consists of all the points $x \in X_{x_0}^*$ such that for all $T, R \in \mathcal{C}$ $(x_0, x)_T \dot{\sim} (x_0, x)_R$. Moreover, for all $x, y \in X_{x_0}^*$ and all $T \in \mathcal{C}$ we have $(x_0, x)_T \dot{\sim} (x_0, y)_T$.[12] The pairs in $X_{x_0}^*$ are perfect candidates for the representation of the pure consumption value of x_0: agent 0 does not care to which subgroup he belongs when choosing among pairs from sets $X_{x_0}^*$. Let

$$X^* := \bigcup_{x_0 \in X} \{(x_0, x) \in X^2 \ : \ x \in X_{x_0}^*\}.$$

Notice that the choice between any two pairs $(x_0, x), (y_0, y) \in X^*$ depends only on x_0 and y_0 and nothing else. In terms of the utilities defined on the previous step, we have

$$U_T[(x_0, x)_T] = U_T[(x_0, y)_T] = U_R[(x_0, x)_R]$$

for all $(x_0, x), (x_0, y) \in X^*$, all $T, R \in \mathcal{C}$.

Define $f : X \to \mathbb{R}$ to be

$$f(x_0) := U_T[(x_0, x)_T]$$

for any $x \in X_{x_0}^*$ and any $T \in \mathcal{C}$ and rewrite U_T as

$$U_T[(x_0, (x_i)_{i \in T})] = f(x_0) + \sum_{i \in T} \pi_T^i u_T(x_0, x_i) \tag{7.1}$$

where $u_T(x_0, x) = \bar{u}_T(x_0, x) - f(x_0)/\sum_i \pi_T^i$ and $u_T(x_0, x) = 0$ for all $(x_0, x) \in X^*$.

3. Fix $i \in S$ and consider all subgroups $C_1, ..., C_k \in \mathcal{C}$ to which i belongs. Then A5 with $Q = \{i\}$ implies that for all $(x_0, x) \in X^2$

$$(x_0, x_i, (x^*(x_0))_{-i})_{C_1} \ \dot{\sim} \ ... \ \dot{\sim} \ (x_0, x_i, (x^*(x_0))_{-i})_{C_k}$$

Therefore,

$$f(x_0) + \pi_{C_1}^i u_{C_1}(x_0, x) = ... = f(x_0) + \pi_{C_k}^i u_{C_k}(x_0, x)$$

implying

$$\pi_{C_1}^i u_{C_1}(x_0, x) = \pi_{C_2}^i u_{C_2}(x_0, x) = ... = \pi_{C_k}^i u_{C_k}(x_0, x) \tag{7.2}$$

[12] Lemma 3 makes sure that there are no other points outside $X_{x_0}^*$ that satisfy these conditions. Thus, $X_{x_0}^*$ is the biggest "unique" set with these properties.

for all $(x_0, x) \in X^2$.

Now fix some $T, R \in \mathcal{C}$ such that there are $i, j \in T \cap R$. Then by the above

$$\pi_T^i u_T(x_0, x) = \pi_R^i u_R(x_0, x) \quad (7.3)$$
$$\pi_T^j u_T(x_0, x) = \pi_R^j u_R(x_0, x) \quad (7.4)$$

By A1 the preferences $\succcurlyeq$ are non-trivial on all subgroups. So there is $(y_0, y) \in X^2$ such that $u_T(y_0, y) \neq 0$. The connectedness of $\mathcal{C}$, positiveness of (π_T^i) and (7.2) implies then that $u_C(y_0, y) \neq 0$ for all $C \in \mathcal{C}$.

The equations (7.3-7.4) hold for (y_0, y). So, by dividing them we obtain

$$\frac{\pi_T^i}{\pi_R^i} = \frac{\pi_T^j}{\pi_R^j} =: L_{T,R} \quad (7.5)$$

for all intersecting T, R and all $i, j \in T \cap R$. If $T \cap R$ has only one element i, then set

$$\frac{\pi_T^i}{\pi_R^i} =: L_{T,R}$$

Notice as well that for $L > 0$

$$f(x_0) + \sum_{i \in T} \pi_T^i u_T(x_0, x_i) = f(x_0) + \sum_{i \in T} \frac{\pi_T^i}{L} \Big(L u_T(x_0, x_i) \Big) \quad (7.6)$$

For intersecting T, R we can rescale all the weights (π_T^i) and u_T using $L_{T,R}$ in place of L in (7.6). This makes the weights for all $i \in T \cap R$ equal in both subgroups. Also rescaled u_T becomes equal to u_R. Denote this rescaled U_T by $L_{T,R}(U_T)$.

4. $\mathcal{C}$ can be represented as a graph. Let all elements of $\mathcal{C}$ be nodes. Two nodes C_1, C_2 are connected by an edge if $C_1 \cap C_2 \neq \emptyset$. By definition of $\mathcal{C}$ the resulting finite graph G is connected.[13]

   For each node $C \in G$ there corresponds a collection of weights (π_C^i) and a status function u_C. Call $\langle G, \{(\pi_C^i), u_C\}_{C \in G} \rangle$ a graph structure.

   Choose any nodes $(T, (\pi_T^i), u_T)$ and $(R, (\pi_R^i), u_R)$ connected by an edge. Rescale U_T to $L_{T,R}(U_T)$ and contract the two nodes into one node $(T \cup R, (\pi_{T \cup R}^i), u_{T \cup R})$, where $u_{T \cup R} = u_R$.

   This turns the structure $\langle G, \{(\pi_C^i), u_C\}_{C \in G} \rangle$ into the structure

$$\langle G_1, \{((\pi_{T \cup R}^i), u_{T \cup R}), ((\pi_C^i), u_C)\}_{C \in G \setminus \{T, R\}} \rangle$$

   where G_1 is a minor of G obtained by the contraction of an edge between T and R.

[13] See the definitions of all graph theoretic terms in Diestel (2000).

Continue contracting edges until there are none left. The sequence of graph structures thus obtained is finite and its last element $\langle G_N, (\pi^i_S), u_S \rangle$ has one node and no edges. By construction, for any agent $i \in S$ the weight π^i_S is the same in all subgroups i belongs to. The status function u_S is also same in all subgroups. Let $\pi_i = \pi^i_S$ and $u = u_S$, then we obtain desired utility $U : \mathcal{A} \to \mathbb{R}$ defined on $\mathfrak{X}_T$ as

$$U_T[h] = E_h[f(x_0) + \sum_{i \in T} \pi_i u(x_0, x_i)]$$

Each U_T is unique up to a positive affine transformation. In addition, all functions U_T are restricted by A5 (AF5) to have the same weights and status functions. Thus the whole U is unique up to a positive affine transformation. ▲

[**2** $\Longrightarrow$ **1**] A1 holds since u is a status function, which is assumed to be not constant. For any $T \in \mathcal{C}$ A2-A3 hold by the "only if" part of the Theorem 8.4 of Fishburn (1970). Additivity of U_T immediately implies A0 and A4. The assumption that u is a status function implies that for each x_0 there is $x^*(x_0)$ such that $u(x_0, x^*(x_0)) = 0$, so A5 follows. It is left to show that A6 holds. Without loss of generality assume that

$$\sum_{i \in S_1} \pi_i > \sum_{i \in S_2} \pi_i$$

where S_1 and S_2 are as in the description of this Theorem. Suppose for some $(x_0, x) \in X^2$ we have $U[(x_0, x)_{S_1}] = U[(x_0, x)_{S_2}]$. Then

$$\sum_{i \in S_1} \pi_i u(x_0, x) = \sum_{i \in S_2} \pi_i u(x_0, x)$$

can happen only when $u(x_0, x) = 0$ since we assume (**??**). Now, take any x' such that $U[(x_0, x')_{S_1}] > U[(x_0, x)_{S_1}]$. This implies that $u(x_0, x') > u(x_0, x) = 0$. But then

$$\sum_{i \in S_1} \pi_i u(x_0, x') > \sum_{i \in S_2} \pi_i u(x_0, x')$$

and therefore $U[(x_0, x')_{S_1}] > U[(x_0, x')_{S_2}]$. This is the first part of A6. Second part is proved by the exactly same argument. ■

8 Lemmata

Lemma 1. *Suppose that $\dot{\succsim}$ satisfies A0-A4. Then for any $T \in \mathcal{C}$, preference relation $\dot{\succsim}$ restricted to $\mathcal{X}_T$ has expected utility representation of the form*

$$U_T[h] = \sum_{i \in T} \pi_T^i E_h[\bar{u}_T(x_0, x_i)]$$

where $\pi_T^i > 0$ for all $i \in T$. Moreover, U_T is unique up to a positive affine transformation.

Proof. Fix any $T \subseteq \mathcal{C}$ and consider the restriction of $\dot{\succsim}$ to $\mathcal{X}_T$. A1-A3 hold for $\dot{\succsim}$ on $\mathcal{X}_T$. Standard compound lotteries rule turns $\mathcal{X}_T$ into a mixture set. Thus, by Theorem 8.4 of Fishburn (1970) $\dot{\succsim}$ on $\mathcal{X}_T$ has expected utility representation

$$U_T[h] = E_h[\bar{u}_T(x_0, (x_i)_{i \in T})].$$

unique up to a positive affine transformation.[14]

Now fix any $x_0 \in X$ and consider the set

$$X_{x_0} := \{(x_0, p) : p \in \Delta(X^T)\}.$$

Let $\sim_*$ be the equivalence relation on X_{x_0} defined by

$$(x_0, p) \sim_* (x_0, q) \quad \Leftrightarrow \quad \Pi\mu_i(p) = \Pi\mu_i(q).$$

Let

$$M_{x_0} := X_{x_0} / \sim_*$$

be the set of equivalence classes of $\sim_*$. M_{x_0} can be described as

$$M_{x_0} = \{(\eta_i)_{i \in T} : \eta_i \in \Delta(X)\} = \Delta^T(X)$$

where element $(\eta_i)_{i \in T}$ corresponds to $(x_0, \Pi\eta_i) \in X_{x_0}$. Let us also use notation $\Pi\mu_i(p) \in M_{x_0}$ to emphasize that $\Pi\mu_i(p) = (\mu_i(p))_{i \in T}$ is the equivalence class of $(x_0, p) \in X_{x_0}$.

Notice that by A0 $h \sim_* z \Rightarrow h \dot{\sim} z$. Thus we can view M_{x_0} as (almost) a set of equivalence classes of $\dot{\sim}$ with some elements still being indifferent under $\dot{\sim}$.[15] It is therefore natural to extend $\dot{\succsim}$ to M_{x_0} by setting

$$(\eta_i)_{i \in T} \dot{\succsim} (\nu_i)_{i \in T} \quad \Leftrightarrow \quad (x_0, \Pi\eta_i) \dot{\succsim} (x_0, \Pi\nu_i)$$

The set M_{x_0} also naturally inherits the mixture set structure from X_{x_0} (which inherits it from $\mathcal{X}_T$) by associating the mixture of two indifference classes with the indifference class of the mixture of any two elements inside those indifference classes. This mixture

[14] I abuse notation by having two functions $\bar{u}_T(x_0, x_i)$ and $\bar{u}_T(x_0, (x_i)_{i \in T})$ with the same name but different arguments. It is always clear from the exposition which function is considered.

[15] $X_{x_0} / \dot{\sim}$ is a partition of X_{x_0}. M_{x_0} is weakly *finer* partition.

set structure will play the pivotal role in the proof, thus it is necessary to show first that this procedure indeed generates mixture set structure on M_{x_0}.

Define a mixture on M_{x_0} by

$$\alpha\Pi\mu_i(p) + (1-\alpha)\Pi\mu_i(q) = \Pi\mu_i(\alpha p + (1-\alpha)q).$$

The first task is to show that this definition is independent of the choice of the choice of p and q: any p' with $\Pi\mu_i(p') = \Pi\mu_i(p)$ and q' with $\Pi\mu_i(q') = \Pi\mu_i(q)$, used in the above definition, should generate the same mixture. Indeed, it is a straightforward property of marginal distributions that

$$\mu_i(\alpha p + (1-\alpha)q) = \alpha\mu_i(p) + (1-\alpha)\mu_i(q).$$

Therefore,

$$\alpha\Pi\mu_i(p) + (1-\alpha)\Pi\mu_i(q) = \Pi(\alpha\mu_i(p) + (1-\alpha)\mu_i(q)).$$

This formula depends only on individual marginals $\mu_i(p)$ and $\mu_i(q)$ and thus is the same for any choice of p' and q'.

The second task is to verify that the mixtures thus defined satisfy the definition of mixture set structure. It is trivial to see that all the assumptions are satisfied (see Definition 8.3 of Fishburn (1970)) since mixture is defined as a function of a mixture of simple lotteries ($p, q \in \Delta(X^T)$) which does possess the mixture set structure.

The resulting formula for the mixture has one important property. When M_{x_0} is viewed as a product space $\Delta^T(X)$ the definition is essentially a *component-wise* mixture:

$$\alpha(\eta_i)_{i\in T} + (1-\alpha)(\nu_i)_{i\in T} = (\alpha\eta_i + (1-\alpha)\nu_i)_{i\in T},$$

which gives us all the ingredients to use additive utility representation result like Theorem 13.1 of Fishburn (1970). At first, M_{x_0} is a component-wise mixture set. At second, $\succcurlyeq$ on M_{x_0} inherits the properties A1-A3 of $\succcurlyeq$ on X_{x_0}, thus satisfying all the requirements of Theorem 13.1 of Fishburn (1970).[16] This is easy to see since preferences and mixing on M_{x_0} were defined through their counterparts on X_{x_0}. Therefore, any properties of preferences are transferred. All this implies that $\succcurlyeq$ on M_{x_0} can be represented by an additive expected utility $\sum_{i\in T} u_T^i(x_0, x_i)$:

$$(\eta_i)_{i\in T} \succcurlyeq (\nu_i)_{i\in T} \quad \Leftrightarrow \quad \sum_{i\in T} E_{\eta_i}[u_T^i(x_0,x)] \geq \sum_{i\in T} E_{\nu_i}[u_T^i(x_0,x)],$$

unique up to a positive affine transformation.[17]

Since $\succcurlyeq$ on M_{x_0} and $\succcurlyeq$ on X_{x_0} are essentially the same orders, we can define the

[16] To verify that $\succ$ is a weak order see Proposition 2.4 of Kreps (1988).

[17] The expectation in this expression is taken with respect to the second argument of the functions $u_T^i(x_0, x)$. The first argument is fixed.

utility of $\succsim$ on X_{x_0} by

$$(x_0, p) \succsim (x_0, q) \quad \Leftrightarrow \quad \sum_{i \in T} E_{\mu_i(p)}[u_T^i(x_0, x)] \geq \sum_{i \in T} E_{\mu_i(q)}[u_T^i(x_0, x)].$$

This means that if A0-A3 hold then it is possible to represent preferences restricted to X_{x_0} for any x_0 by an additive expected utility function. X_{x_0} is a mixture set and thus by the only if part of Theorem 8.4 of Fishburn (1970) any utility that represents $\succsim$ on X_{x_0} is a positive affine transformation of any other utility. This implies, in particular, that representation $\bar{u}_T(x_0, (x_i)_{i \in T})$ for $\succsim$ on $\mathcal{X}_T$ obtained in the beginning of this proof should be positive affine transformation of some additive utility function for any x_0, since $\bar{u}_T(x_0, (x_i)_{i \in T})$ restricted to any X_{x_0} still represent $\succsim$ on it. Therefore, for all x_0 it is possible to write

$$\bar{u}_T(x_0, (x_i)_{i \in T}) = a_{x_0} \sum_{i \in T} u_T^i(x_0, x_i) + b_{x_0} = \sum_{i \in T} \left(a_{x_0} u_T^i(x_0, x_i) + \frac{b_{x_0}}{|T|} \right) = \sum_{i \in T} \bar{u}_T^i(x_0, x_i)$$

where $a_{x_0} > 0$ and b_{x_0} is some number.

To finish the proof of this Lemma it is left to show that all functions $\bar{u}_T^i$ are multiples of one another. We use A4 to achieve that. Indeed, by A4, for all $i, j \in T$ and any $\ell, m \in \Delta(X^2)$ it is true that

$$E_\ell[\bar{u}_T^i(x_0, x)] \geq E_m[\bar{u}_T^i(x_0, x)] \quad \Leftrightarrow \quad E_\ell[\bar{u}_T^j(x_0, x)] \geq E_m[\bar{u}_T^j(x_0, x)],$$

which can happen only if $\bar{u}_T^i$ and $\bar{u}_T^j$ are positive affine transformations of one another. This implies that for all $i \in T$ we can write

$$\bar{u}_T^i(x_0, x) = a_i \bar{u}_T^1(x_0, x) + b_i$$

where $\{1\} \in T$, $a_i > 0$ and b_i is some number. Let $\bar{u}_T(x_0, x) = \bar{u}_T^1(x_0, x) + \sum_i b_i / \sum_i a_i$ and denote $\pi_T^i = a_i$. Then

$$\bar{u}_T^i(x_0, x) = \sum_{i \in T} \pi_T^i \bar{u}_T(x_0, x_i)$$

and $U_T[h] = \sum_{i \in T} \pi_T^i E_h[\bar{u}_T(x_0, x_i)]$ represents $\succsim$ as desired. ■

Lemma 2. *Suppose A5-A6 hold. Then for all $C_1, C_2 \in \mathcal{C}$, all $x_0 \in X$ and all $x^*(x_0) \in X$ satisfying A5*

$$(x_0, x^*(x_0))_{C_1} \sim (x_0, x^*(x_0))_{C_2}$$

Proof. Let us first assume that $C_1 \cap C_2 \neq \emptyset$. Then by putting $x = x^*(x_0)$ in the definition of A5 we get the desired

$$(x_0, x^*(x_0))_{C_1} \sim (x_0, x^*(x_0))_{C_2}$$

Now, $\mathcal{C}$ is the connected collection of subsets (see Definition 5). Therefore, any two disjoint subgroups can be connected by the sequence of intersecting ones. Therefore, by transitivity of $\dot{\sim}$ the result above holds for all $C_1, C_2 \in \mathcal{C}$. ■

Lemma 3. *Suppose A5-A6 hold. Then for all $x_0 \in X$ there exists a non-empty set*

$$X^*_{x_0} = \{x \in X : \forall T, R \in \mathcal{C} \;\; (x_0, x)_T \;\dot{\sim}\; (x_0, x)_R\}.$$

Moreover, for all $x_0 \in X$, $x, y \in X^*_{x_0}$ and all $T \in \mathcal{C}$

$$(x_0, x)_T \;\dot{\sim}\; (x_0, y)_T$$

Proof. A5 says that for all $x_0 \in X$ there is $x^*(x_0)$, which by Lemma 2 satisfies the condition for being a member of $X^*_{x_0}$. Therefore, we have shown that non-empty $X^*_{x_0}$ exists for all x_0.

Now suppose that the second condition of the Lemma does not hold. In other words, there is x_0 and $x, y \in X^*_{x_0}$ such that for some $T \in \mathcal{C}$

$$(x_0, x)_T \;\dot{\succ}\; (x_0, y)_T$$

Let $S_1, S_2 \in \mathcal{C}$ be the two subgroups satisfying A6. Then, by definition of y

$$(x_0, y)_{S_1} \;\dot{\sim}\; (x_0, y)_{S_2}$$

Moreover, the definitions of x and y and the assumption give

$$(x_0, x)_{S_1} \;\dot{\sim}\; (x_0, x)_T \;\dot{\succ}\; (x_0, y)_T \;\dot{\sim}\; (x_0, y)_{S_1}$$

The two conditions above and A6 imply that

$$(x_0, x)_{S_1} \;\dot{\succ}\; (x_0, x)_{S_2}$$

which contradicts the fact that x is an element of $X^*_{x_0}$. ■

9 Notation

Object	Definition
X	set of prizes. Can be any non-singleton set
S	finite non-singleton set of all other agents. Does not include agent 0: $\{0\} \notin S$
$T, R, C, Q \subseteq S$	non-empty subsets (subgroups) of S
$i, j \in T$	refer to individual other agents
$k \in K$	refers to an element of some finite set K. It is usually used to enumerate the elements of the support of the lotteries. Reference to K is suppressed whenever the set in question is not important
$\mathcal{C} \subseteq 2^S$	collection of subgroups
$\Delta(X)$	set of all simple lotteries (with finite support) over set X. The same meaning applies to any other set in place of X
$x_0, x, x_i \in X$	statuses (possessions) of agents. x_0 always refers to agent 0. x and x_i refer to any other agent i
$\mathbf{x}, (x_i)_{i\in T} \in X^T$	vectors of possessions of other agents in T. The same objects are thought to belong to $\Delta(X^T)$ as degenerate lotteries
$\mathbf{x}_{-i} \in X^{T\setminus\{i\}}$	vector $\mathbf{x}$ without ith element
$\mathcal{X}_T := \Delta(X^{\{0\}\cup T})$	the set of all simple lotteries over the possessions of agent 0 and all others in T
$(x_0, x)_T \in X^{\{0\}\cup T}$	degenerate element of $\mathcal{X}_T$ that assigns x_0 to agent 0 and $x \in X$ to each other agent in T
$h, z, w \in \mathcal{X}_T$ $(\mathcal{E}_T)$	typical elements of $\mathcal{X}_T$
$p, q, r \in \Delta(X^T)$	typical elements of $\Delta(X^T)$
$\ell, m \in \Delta(X^2)$	typical elements of $\Delta(X^2)$
$\eta, \nu \in \Delta(X)$	typical elements of $\Delta(X)$
$a, b \in \mathbb{R}$	numbers
$(x_0, p) \in \mathcal{X}_T$	element of $\mathcal{X}_T$ with agent 0 having deterministic outcome $x_0 \in X$ and others having $p \in \Delta(X^T)$
$(\ell, \mathbf{x}_{-i}) \in \mathcal{X}_T$	the lottery in $\mathcal{X}_T$ that has deterministic outcomes for all others except agent i. Agent 0's and i's possessions are jointly distributed according to $\ell \in \Delta(X^2)$
$\alpha, \beta, \pi \in [0,1]$	probabilities
$[\alpha_k, (x_0^k, \mathbf{x}^k)] \in \mathcal{X}_T$	refers to a lottery in $\mathcal{X}_T$ that assigns probability α_k to $(x_0^k, \mathbf{x}^k) \in X^{\{0\}\cup T}$. k goes over some finite set K suppressed for convinience
$\mu_0(h), \mu_i(h), \mu_i(p)$	for $h \in \mathcal{X}_T$, $\mu_0(h)$ and $\mu_i(h)$ are marginal distributions of agent 0's and agent i's possessions. For $p \in \Delta(X^T)$, $\mu_i(p)$ is the marginal distribution agent i's possessions
$\Pi\mu_i(p) \in \Delta(X^T)$	a lottery over the possessions of others in T obtained from any $p \in \Delta(X^T)$ by taking all marginals $\mu_i(p)$ and treating them as independent distributions
$\pi_i \in \mathbb{R}_{++}$	positive real numbers that denote social weights of others
$\mathcal{A} := \cup_{T\in\mathcal{C}} \mathcal{X}_T$	union of all $\mathcal{X}_T$ sets

References

Andreoni, J. (1995): "Cooperation in Public-Goods Experiments: Kindness or Confusion?," *American Economic Review*, 85(4), 891–904.

Anscombe, F., and R. Aumann (1963): "A Definition of Subjective Probability," *Annals of Mathematical Statistics*, 34(1), 199–205.

Auriol, E., and R. Renault (2008): "Status and incentives," *RAND Journal of Economics*, 39(1), 305–326.

Ball, S., C. C. Eckel, P. J. Grossman, and W. Zame (2001): "Status in Markets," *Quarterly Journal of Economics*, 116(1), 161–188.

Bolton, G. E., and A. Ockenfels (2000): "ERC: A Theory of Equity, Reciprocity, and Competition," *American Economic Review*, 90(1), 166–193.

Charles, K. K., E. Hurst, and N. Roussanov (2008): "Conspicuous consumption and race," forthcoming, QJE.

Costa-Gomes, M., and K. G. Zauner (2001): "Ultimatum Bargaining Behavior in Israel, Japan, Slovenia, and the United States: A Social Utility Analysis," *Games and Economic Behavior*, 34, 238–269.

Cummins, D. (2005): "Dominance, Status, and Social Hierarchies," in *The Handbook of Evolutionary Psychology*, ed. by D. M. Buss, chap. 20, pp. 676–697. John Wiley & Sons, Inc.

De Graaf, J., D. Wann, and T. H. Naylor (2005): *Affluenza: The All-Consuming Epidemic*. Berrett-Koehler Publishers.

Diestel, R. (2000): *Graph Theory*. Springer-Verlag New York, Inc., 2nd edn.

Dufwenberg, M., and G. Kirchsteiger (2004): "A theory of sequential reciprocity," *Games and Economic Behavior*, 47, 268–298.

Falk, A., and U. Fischbacher (2006): "A theory of reciprocity," *Games and Economic Behavior*, 54, 293–315.

Fehr, E., and S. Gächter (2000): "Cooperation and Punishment in Public Goods Experiments," *American Economic Review*, 90(4), 980–994.

Fehr, E., and K. M. Schmidt (1999): "A Theory of Fairness, Competition, and Cooperation," *Quarterly Journal of Economics*, 114(3), 817–868.

Fishburn, P. C. (1970): *Utility theory for decision making*. John Wiley & Sons, Inc.

Frank, R. H. (1985): *Choosing the Right Pond: Human Behavior and the Quest for Status*. New York: Oxford University Press.

Herstein, I., and J. Milnor (1953): "An Axiomatic Approach to Measurable Utility," *Econometrica*, 21(2), 291–297.

Kreps, D. M. (1988): *Notes on the Theory of Choice*, Underground Classics in Economics. Westview Press, Inc.

Layard, R. (1980): "Human Satisfaction and Public Policy," *The Economic Journal*, 90, 737–750.

Levine, D. K. (1998): "Modeling Altruism and Spitefulness in Experiments," *Review of Economic Dynamics*, 1(3), 593–622.

Luttmer, E. F. P. (2005): "Neighbors as negatives: relative earnings and well-being," *Quarterly Journal of Economics*, 120(3), 963–1002.

Massey, D. S., J. Arango, G. Hugo, A. Kouaouci, A. Pellegrino, and J. E. Taylor (1993): "Theories of international migration: a review and appraisal," *Population and Development Review*, 19(3), 431–466.

McCabe, K. A., M. L. Rigdon, and V. L. Smith (2003): "Positive reciprocity and intentions in trust games," *Journal of Economic Behavior and Organization*, 52, 267275.

Ok, E. A., and L. Koçkesen (2000): "Negatively interdependent preferences," *Social Choice and Welfare*, 17, 533–558.

Rustichini, A., and A. Vostroknutov (2006): "Competition with skill, luck: fMRI study," mimeo, University of Minnesota.

——— (2007): "Competition with skill and luck," University of Minnesota.

Smith, A. (1759): *The Theory of Moral Sentiments*. London: A. Millar.

Veblen, T. (1899): *The Theory of Leisure Class: An Economic Study of Institutions*. London: Allan and Unwin.