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On Interpersonal Utility Comparisons*)

by

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Abstract: This paper argues that meaningful interpersonal comparisons of utility levels are difficult even in principle and that assuming the possibility of meaningful interpersonal comparisons of utility differences is almost the same as assuming the existence of a separable social welfare function.

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1. Introduction

The problem of interpersonal utility comparisons is one of the most important and controversial issues in welfare economics and moral philosophy. In the tradition of economics, interpersonal utility comparisons have been rejected as having 'no meaning' or 'no objective validity' , though there has been no very persuasive argument against interpersonal utility comparisons. However since Harsanyi (1955) eloquently argued that interpersonal utility comparisons were possible in principle even though difficult in practice, there has been a tendency which has not rejected interpersonal utility comparisons as impossible. At present, many authors recognize such comparisons as the basis of ethical judgements and derivations of social welfare functions, e.g., Harsanyi (1955,1975), Sen (1970,1977), Simon (1974), Hammond (1976,1977), d'Aspremont and Gevers (1977), Maskin (1978), Roberts (1980a,b) and many others. Unfortunately, these works except Harsanyi's did not attempt to give any concrete definition to interpersonal utility comparisons nor to rationalize the interpersonal comparability, that is, they assumed certain forms of interpersonal utility comparisons were possible and considered the implications of them. Furthermore Harsanyi's argument and definition are not yet fully clear and it is still necessary to reflect on the interpersonal comparability.

This paper considers two notions of interpersonal utility comparabilities. One is the interpersonal comparability of utility levels and another one is the interpersonal comparability of utility differences. Initially this paper argues that meaningful interpersonal comparisons of utility levels are difficult in principle even though we stand on Harsanyi's position. Next it argues that assuming the possibility of meaningful interpersonal comparisons of utility differences is almost the same as assuming the existence of a separable social

welfare function. It is concluded that interpersonal comparisons of utility differences are not the basis of the construction of a social welfare function but rather are derived from a separable social welfare function or simulteneously they are defined.

2. The Interpersonal Comparability of Utility Levels[1)]

1). We begin with considering formal requirements for the interpersonal comparability of utility levels. Let X be the set of all alternative states and N the set of all individuals. The interpersonal comparability of utility levels requires that there exist a common extended utility function $U(x,i)$ on $X \times N$. For each $i \in N$, $U(.,i)$ coincides with individual i's intrapersonal utility function.[2)] Furthermore interpersonal comparisons of utility levels, e.g., $U(x,i) > U(y,j)$, make sense, that is, it is meaningful to say that being individual i in alternative x gives a higher utility than being j in y. The most crucial requirement is that this $U(.,.)$ does not depend upon individuals. Otherwise, i.e., each individual has an extended utility function $U_i(.,.)$ on $X \times N$, this is just the assumption that each individual has interests in others and their states. There is no conceptual difficulty in assuming this but this does not yield any meaningful interpersonal comparisons of utility levels. Our purpose is to consider the logical validity of the existence of such a common extended utility function $U(.,.)$ which also permits interpersonal comparisons of utility levels.

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1). In this paper, the word 'utility' is used in a little broader sense than in the standard economics. If necessary, 'utility' can be replaced by 'welfare'.

2). Exactly speaking, the preference induced by $U(.,i)$ coincides with individual i's intrapersonal preference.

The assumption that U(.,.) is common among the individuals is not to choose one representative individual whose extended utility function is employed as the common one. If so, we meet another problem of the choice of a representative individual . This problem can be solved without difficulty only if there exists a common extended utility function which does not depend upon individuals. If an observer (a scientist) can know U(.,.) with very elaborate theory and devices , then every individual with the same knowledge with the observer's must agree the comparisons made by U(.,.), i.e., his preference on X× N is correctly described by U(.,.). Otherwise, U(.,.) is no more than the observer's own individual extended utility function. Therefore it is required that every individual in certain condition be able to know the common extended utility function.

2). Harsanyi (1955) gave an argument for the interpersonal comparability of utility levels, which would satisfy the above requirements.[3] In fact, he claimed that complete knowledge on "natural law" (psycological law) would derive the common extended utility function which also could give meaningful interpersonal comparisons of utility levels. In this subsection we survey his argument. Since Harsanyi's argument is quite stringent, it is hard to avoid his argument in order to define meaningful interpersonal comparisons of utility levels satisfying the above requirements. This will be also pointed out in place.

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3). In fact, he claimed also that interpersonal comparisons of utility differences were possible. Since he assumed von Neumann-Morgenstern utility functions, the interpersonal comparability of utility levels implies the comparability of utility differences.

He postulates that utility functions are determined by natural law (psycological law).[4] If two individuals have different utility functions, then the differences can be traced to the differences between them in physical and historical conditions. If the physical condition and the past history of individual i are given, complete knowledge of natural law could permit the prediction of U(.,i). Suppose that the physical and historical conditions of individual i are described by a vector of parameters $p = (p_1, p_2, \ldots, p_c)$. Let C be the set of all indices of the parameters,which are callled personal characteristics. Then individual i's utility function is given as

$$U(.,i) = f(.,p) , \qquad (1)$$

where the function f must be the same for every individual. This f is called the universal utility function.

The mere fact that individual utility functions can be expressed in the form of (1) does not yet establish the interpersonal comparability of utility levels. One needs an additional assumption:(The Principle of Hypothetical Preference Judgements(Principle HPJ)); an individual can make meaningful preference comparisons involving different values of the parameters p and these judgements are correctly expressed by f.

For example, one of the parameters p_k ($k \in C$) may be the size of a person. Somebody may say : I would be happy to lose 20% of my income if in exchange I could be 10 centimeter taller. Let x be the initial alternative and y be the latter in which his income is replaced by 80% of the original income level. Let q_k be the size which is 10 centimeter taller than p_k. Formally, he says

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4). The following explanation is based on Harsanyi (1975) and Selten (1982).

that $f(x,p_k,p_{C-\{k\}}) < f(y,q_k,p_{C-\{k\}})$, where $p_{C-\{k\}} = (p_j)_{j\in C-\{k\}}$. In this case, interpersonal comparisons in body size are reduced into intrapersonal comparisons by regarding body sizes like as intrapersonal decision variables. Harsanyi claims that in the same manner any interpersonal comparisons can be reduced into intrapersonal comparisons by regarding personal characteristics like as intrapersonal decision variables. Thus Harsanyi justified the principle HPJ.

At present, interpersonal utility comparisons are difficult because of lack of knowledge on natural law and informational constraints on personal characteristics. However it is possible in principle to make interpersonal comparisons and the prediction of the universal utility function f will become more accurate as knowledge on natural law and personal characteristics will be accumulated. This is an implication of Harsanyi's argument.[5)]

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5). A similar reasoning seems to be presumed in the works of the construction of social welfare functions from the viewpoint of informational constraints, e.g., Sen (1977), Hammond (1977), d'Aspremont and Gevers (1977), Maskin (1978), Roberts (1980a,b) and others. This approach has two possible interpretations: One is that informational constraints prohibit interpersonal utility comparisons and if information is sufficient for some form of interpersonal comparisons, they are possible. This is the same as the implication of the above argument. Another one is that interpersonal comparability itself corresponds to some informational constraint, that is, the impossibilty of some form of interpersonal comparisons is called an "informational" constraint. As Sen (1977,page 1548) pointed out that axiomizing moral principles through informational constraints might appear as a confusion of ethical and epistemological considerations , the terminolgy "informational" constraint is quite confusing if we employ the second interpretation.

3). The postulate that utility functions are determined by natural law might be a consistent view if we interpret 'natural law' in a very wide sense. In fact, the author has strong doubt on this postulate, because utility functions are influenced by history and simulteneously utility functions are important factors which determine the history itself. If utility functions are parts of social conventions or customs,[6] then the mere physical conditions might not determine utility functions, that is, utility functions are affected by social customs which are also affected by the utility functions themselves. Thus a simple function form like (1) could not determine utility functions. Anyway, let us accept the postulate and consider the consequence of the argument of the above subsection in the following. We will return to this problem again in the next subsection.

Note that if we reject the postulate, then there is no universal utility function. In this case it is quite difficult to justify the existence of a common extended utility function, which denies the requirement discussed in Subsection 2.1.

Let us return to the above example of the choice between body sizes and income levels. Although this example allows to reduce interpersonal comparisons into intrapersonal comparisons, his decision still depends upon the rest of his personal characteristics $p_{C-\{k\}}$. The dependence of his utility function on $p_{C-\{k\}}$ is equivalent to say that if $q_{C-\{k\}}$ is different from $p_{C-\{k\}}$, then it would not necessarily be true that

$$\begin{aligned} &f(x,p_k,p_{C-\{k\}}) \succ f(y,q_k,p_{C-\{k\}}) \text{ if and only if} \\ &f(x,p_k,q_{C-\{k\}}) \succ f(y,q_k,q_{C-\{k\}}) . \end{aligned} \tag{2}$$

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6). For general explation of "convention" or "custom", see Leweis (1969) and also Kaneko (1981).

It would be impossible to argue that (2) is true independently of the rest of personal characteristics, because otherwise every individual has the identical utility function on the set of alternatives and body sizes.

However we can decrease the degree of the dependence on the rest of personal characteristics by regarding other personal characteristics like as intrapersonal decision variables. Let C_o be a set of personal characteristics. Suppose that the characteristics in C_o are reduced into intrapersonal decision variables. In this case,decisions still depend upon values on $C-C_o$, that is, if $p_{C-C_o} (= (p_k)_{k \in C-C_o}) \neq q_{C-C_o}$, then it is not necessarily true that

$$\begin{aligned} &f(x,p_{C_o},p_{C-C_o}) > f(y,q_{C_o},p_{C-C_o}) \text{ if and only if} \\ &f(x,p_{C_o},q_{C-C_o}) > f(y,q_{C_o},q_{C-C_o}) \ . \end{aligned} \tag{3}$$

Therefore there are two logical possibilities for (3) to be always true:

(i): $C_o = C$, i.e., all personal characteristics are reduced into intrapersonal decision variables.

(ii): There is a nonempty $C-C_o$ with a unique p_{C-C_o} , i.e., there are common personal characteristics among human beings.

It would be clear that (3) is always true in cases (i) and (ii).

4). Let us consider case (i), i.e., $C_o = C$. In this case decision makers lost any personal characteristics. Of course, all emortions, e.g., desire, hope, love, hatred,etc., are involved or yielded by the personal characteristics. Then we meet the problem of whether or not such decision makers without personal characteristics can make decisions.

In order to consider this problem, we provide a model of individual (human being); a model of individual consists of

(A): personal characteristics, i.e., physical, phsycological and historical facters; and

(B): complete reason.

It would not be nessary to explain personal characteristics. The other part of the model is complete reason, which means the abilities of calculation, perception and information processing. The completeness of reason means that these abilities are not bounded and costlessly performed. [7] That is, the complete reason is the complete computer which does not have any physical entity. If it has a physical entity, the physical part of it is involved by personal characteristics. If everything of the model is categolized into personal characteristics, then decision makers without personal characteristics do not have any physical and spritual entity, which implies that in fact, the above question of whether or not decision makers without personal characteristics can make decisions is answered in negative, because the decision makers themselves disappear. Therefore it is necessary to consider the above model of individual consisting of (A) and (B). This model is implicitly assumed in the standard game theory and economics.

Let us apply the above model to case (i). The answer is quite clear. A decision maker whose personal characteristics are subtracted completely is the

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7). This concept of complete reason is the same as von Neumann's 'abstraktes Ich' in (1932) and also close to Kant's 'reason' in (1785). See also Feldman (1978,Chap.8).

complete computer which can only calculate and perceive situations completely. The computer can not make any decision by itself unless it is given some rules for decision making. The assumption that $C_o = C$ implies that decision makers in question have just the complete reason but not any rules for decision making. Therefore we can conclude that the decision makers can not make any decision. Thus the complete reason perceives the other individuals' situations but it can not make any interpersonal comparisons of utility levels.

5). Let us consider case (ii), i.e., there is a nonempty $C-C_o$ with a unique p_{C-C_o}. If the personal characteristics in $C-C_o$ are not sufficient for decision making, then this case is also the same as case (i). Let us assume that the list p_{C-C_o} of the personal characteristics is sufficient for decision making. This case is rather close to the standard position of welfare economists and moral philosophers. However this case can be again divided into two different ones.

The first is: Every member of a society shares a common moral feeling (knowledge) which comes as conventions or customs of the society.[8] This common moral feeling is involved by p_{C-C_o}.

If we stand on this position, utility functions are also determined by social conventions or customs to a certain extent. As discussed in Subsection 2.3, this view might contradict the postulate that utility functions are determined by natural law. Furthermore it is quite natural that the moral feeling depends upon the society, i.e., as a society has different customs from other societies', a common moral feeling differs from the other societies'. From this viewpoint it might be true that interpersonal comparisons are possible in a society but universal interpersonal comparisons are not yet implied.

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8). See footnote 5.

The second one is: An intrinsic moral feeling exists in every human being's mind independently of societies and it governs every human being, which is involved by p_{C-C_o}. Since information on personal characteristics is incomplete, it is hard for individual moral judgements to coincide. If information is complete and every individual refelects on his mind, he can remember the common moral feeling.

This view might be logically consistent like as the postulate that utility functions are determined by natural law might be consistent. This view can be hardly rejected and simulteneously can be hardly justified. This view can be claimed only because it does not yield any logical inconsistency. If we accept this view, progress in science (in a narrow sense) could solve every ethical problem and each individual needs only to reflect on his mind using knowledge on physical conditions. Moral and ethical investigations are just the attempt to remember our intrinsic moral feeling. This author can not accept this view unless reasons or evidences for the existence of such an intrinsic moral feeling are given.

Finanlly we have to give a comment to the opinion that people do make, or at least attempt to make, interpersonal utility comparisons. From the above arguments, people can make interpersonal comparisons to a certain extent but it is quite difficult for such comparisons to be meaningful. Saying that people make interpersonal comparisons is equivalent to saying that people can think of others' situations and interests. Of course, it is possible, but is not an evidence for the possibility of meaningful interpersonal comparisons.

3. The Interpersonal Comparability of Utility Differences [9)]

1). Interpersonal comparisons of utility differences have a much clearer welfare implication than interpersonal comparisons of utility levels. In fact, this subsection argues that meaningful interpersonal comparisons of utility differences are possible if and only if certain distribution problems are solved from the viewpoint of social welfare. The next subsection will provide a mathematical formulation for this equivalence.

Consider the following simple distribution problem: There is an indivisible unit of some good which will be distributed between two individuals i and j. [10)] Assume that the other members of this society are indifferent between giving this unit to i and to j. Let x be the initial state where neither of i and j is given this unit, and y (respectively,z) be the state where i (j) is given but j (i) is not. Assume also that i (j) is indifferent between x and z (y) . In this case, interpersonal comparisons of utility differences can answer the question of which of the utility differences from x to y and from x to z is bigger or the same. If the utility difference from x to y is bigger than that from x to z , then the unit must be given to individual i. Because if this judgement was rejected, then there is no substantial meaning of the interpersonal comparisons of utility differences. Therefore if meaningful comparisons of utility differences are possible, then distribution problems like the above example must be solved by making interpersonal comparisons.

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9). See footnote 1.

10). The assumption of indivisibility is used only for the simplicity of explanation.

On the other hand, distribution problems can be always solved if there exists a social welfare function. If we claim that the social welfare function is meaningful and also that meaningful interpersonal comparisons of utility differences are possible, then it is natural to require that judgements for distribution problems made by the social welfare function coincide with those made by the interpersonal comparisons. If this requirement was rejected, then we could not make any welfare judgement for distribution problems because there are two inconsistent welfare criteria. This requirement is called The Equivalence Principle of Judgements made by a Social welfare Function and Interpersonal Comparisons of Utility Differences (abbre. The Equivalence Principle).

2). This subsection provides a mathematical formulation of the Equivalence Principle and shows that it implies that the social welfare function is separable.

For simpicity, we consider a Bergsonian social welfare function W which is defined on a subset of the n-dimensional Euclidean space. We assume that $Y = (a,+\infty)^n = (a,+\infty)\times \ \ldots \ \times(a,+\infty)$, where a might be $-\infty$. This Y is the space of n-tuples of 'utility' values. We presume that 'utility scales' are specified by some utility theory. [11)]

Let g be a continuous monotone function on $(a,+\infty)$ with $\lim_{\alpha \to +\infty} g(\alpha) = +\infty$. The transformation $g(u_i)$ of utility values allows interpersonal comparisons of utility differences, that is, if $g(u_i') - g(u_i) > g(u_j') - g(u_j)$, then

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11) The von Neumann-Morgenstern utility theory is a candidate for such theories.

the difference from u_i to u_i' is bigger than from u_j to u_j'.[12] In the above example, $g(U_i(y)) - g(U_i(x)) > g(U_j(z)) - g(U_j(x))$, where U_i and U_j are individuals i's and j's utility functions. The Equivalence Principle is as follows:

The Equivalence Principle: For any $i, j \in N$ ($i \neq j$) and u_i', u_j', $u_{-ij} = (u_k)_{k \in N-\{i,j\}}$ with $(u_{-ij}, u_i, u_j'), (u_{-ij}, u_i', u_j) \in Y$, it holds that

$$g(u_i') - g(u_i) > g(u_j') - g(u_j) \quad \text{if and only if}$$
$$W(u_{-ij}, u_i', u_j) > W(u_{-ij}, u_i, u_j'). \tag{4}$$

$$g(u_i') - g(u_i) > g(u_j') - g(u_j) \iff W(u_{-ij}, u_i, u_j) \searrow\!\swarrow W(u_{-ij}, u_i', u_j) > W(u_{-ij}, u_i, u_j')$$

Diagram 1.

Proposition. If the Equivalence Principle holds, then for all $u, v \in Y$,

$$W(u) > W(v) \quad \text{if and only if} \quad \sum_{i \in N} g(u_i) > \sum_{i \in N} g(v_i). \tag{5}$$

Proof. See the appendix.

Thus if we accept the existence of a meaningful social welfare function and also meaningful interpersonal comparisons of utility differences, then the social welfare function must be separable. Conversely, if there is a

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12) Here we assume that g is common independently of individuals. However even though it depends upon individuals, each function g_i can be transformed into an identical one by transforming utility values appropriately.

separable social welfare function, interpersonal comparisons of utility differences are defined by the Equivalence Principle. Logically speaking, assuming the interpersonal comparability of utility differences is not equivalent to doing the existence of a social welfare function. However these are almost equivalent except the point that interpersonal comparisons of utility differences can answer only distribution problems like the example of Subsection 2.1 but a social welfare function can do any. If we accept the interpersonal comparability, then it is natural to accept the existence of a social welfare function and also the Equivalence Principle.

In this case there are several possibilites of logical directions for giving definitions to social welfare and interpersonal comparisons of utility differences. The first one is that we define a social welfare function without using interpersonal comparisons and derive interpersonal comparisons from the Equivalence Principle. The second is that we define interpersonal comparisons without using any social welfare function and derive a social welfare function from the Equivalence Principle.

For example, the Nash social welfare function of Kaneko and Nakamura (1979a,b) is a separable one, which is defined without any presumption of the interpersonal comparability. This implies that the first direction is possible. The second has a similar difficulty with the interpersonal comparability of utility levels as discussed in Section 2, because the interpersonal comparability of utility differences must be defined without using any social welfare function and the Equivalence Principle and therefore drops into a similar argument as Section 2.

The last posssibility is that we require a meaningful social welfare function to provide meaningful interpersonal comparisons of utility (welfare) differences. That is, the interpersonal comparability of utility differences and the Equivalence Principle are involved by the axioms which determine the social welfare function. This possibility is not so different from the first and as the first is possible, this is possible.

4. Conclusion

This paper investigated the two notions of interpersonal comparabilities of utility. It was argued that meaningful interpersonal comparisons of utility levels are difficult even in principle but that assuming interpersonal comparisons of utility differences is almost the same as assuming the existence of a separable social welfare function. It was also suggested that a separable social welfare function could define interpersonal comparisons of utility differences . This logical direction would be possible but the converse would be difficult as well as giving the definition of interpersonal comparisons of utility levels is difficult. Furthermore it follows from the arguments of this paper that interpersonal comparisons of utility differences are relevant for distribution problems but not comparisons of utility levels. Thus only interpersonal comparisons of utility differences are meaningful but derived by a separable social welfare function.

Appendix

Proof of the Proposition

Lemma 1. For any $i,j \in N$ ($i \neq j$), $g(u_i) + g(u_j) = g(v_i) + g(v_j)$ if and only if $W(u_{-ij},u_i,u_j) = W(u_{-ij},v_i,v_j)$.

Proof. Obvious.

Lemma 2. $\sum_{i \in N} g(u_i) = \sum_{i \in N} g(v_i)$ if and only if $W(u) = W(v)$.

Proof. We prove this lemma by induction. Suppose that for some k and any $u,v \in Y$ with $u_i = v_i$ for all $i = k+1,\ldots,n$, $\sum_{i=1}^{k} g(u_i) = \sum_{i=1}^{k} g(v_i)$ if and only if $W(u) = W(v)$. Assume that $\sum_{i=1}^{k+1} g(u_i) = \sum_{i=1}^{k+1} g(v_i)$. Choose $\bar{u}_k$, $\bar{v}_k$ and d such that $g(\bar{u}_k) + g(d) = g(u_k) + g(u_{k+1})$ and $g(\bar{v}_k) + g(d) = g(v_k) + g(u_{k+1})$. This choice is possible by the continuity of g and $\lim_{\alpha \to +\infty} g(\alpha) = +\infty$. Then it follows from Lemma 1 and the assumption of induction that $W(u_1,\ldots,u_n) = W(u_1,\ldots,u_{k-1},\bar{u}_k,d,u_{k+2},\ldots,u_n) = W(v_1,\ldots,v_{k-1},\bar{v}_k,d,u_{k+2},\ldots,v_n) = W(v_1,\ldots,v_k,v_{k+1},u_{k+2},\ldots,u_n)$. Conversely suppose $W(u_1,\ldots,u_n) = W(v_1,\ldots,v_{k+1},u_{k+2},\ldots,u_n)$. For the above $\bar{u}_k,\bar{v}_k$ and d, it holds by Lemma 1 that $W(u_1,\ldots,u_{k-1},\bar{u}_k,d,u_{k+2},\ldots,u_n) = W(v_1,\ldots,v_{k-1},\bar{v}_k,d,u_{k+2},\ldots,u_n)$. Therefore we have, by the assumption of induction, $\sum_{i=1}^{k+1} g(u_i) = \sum_{i=1}^{k-1} g(u_i) + g(\bar{u}_k) + g(d) = \sum_{i=1}^{k-1} g(v_i) + g(\bar{v}_k) + g(d) = \sum_{i=1}^{k+1} g(v_i)$.

It follows from Lemma 2 that there exists a real-valued function f on the reals such that

$$W(u) = f\Big(\sum_{i \in N} g(u_i)\Big) \quad \text{for all } u \in Y .$$

The monotonicity of f is easily derived from the Equivalence Principle. Therefore it holds that $W(u) > W(v)$ if and only if $\sum_{i \in N} g(u_i) > \sum_{i \in N} g(v_i)$.

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