GAME THEORY, DECISION THEORY, AND SOCIAL CHOICE THEORY IN THE CONTEXT OF A NEW THEORY OF EQUITY

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SUMMARY

Some of the interrelationships between game theory, axiomatic social choice theory, and ethics are set forth in the context of a new theory of equity. One of the principal functions of the new theory is to explicate alternative intuitive concepts of equity such as "To Each According to His Needs," and "To Each According to His Contribution." Game theoretic methods are used not only to provide an unambiguous, analytical characterization of these (and other) concepts, but also to integrate the various concepts within a single, coherent account of equity. Additionally, a new concept of impartiality is introduced--one which dispenses with the need for a Rawls-Harsanyi "Veil of Ignorance" construct. At a methodological level, the new theory makes possible a new interpretation of two cooperative game solution concepts: the generalized (nontransferable utility) Shapley Value, and the Nash bargaining solution. Moreover, it frees moral theory from the need to make interpersonal comparisons of utility at an operational level. All in all, the new theory should deepen the reader's understanding of various concepts of "fairness," in applications ranging from negotiation theory to abstract moral theory.

In Section II, the reader is furnished with an overview of the basic structure of the new theory. In Section III, the subtheory of distribution according to relative needs is developed. Here attention is drawn to the mathematical equivalence of the ethical model developed in this theory with the Nash-Harsanyi theory of pure n-person bargaining games and with the Kaneko-Nakamura version of axiomatic social choice theory. In Section IV, the subtheory of distribution according to relative contribution is discussed. And Section V presents an informal characterization of a two-stage game, which when played, will realize "full distributive justi e" as understood in the new theory.

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I INTRODUCTION

In recent years, decision theory and axiomatic social choice theory have provided the basis for some searching investigations into the problem of social justice. And yet game theory proper, which is a generalization of decision theory, has not played a correspondingly important role in ethics. The purpose of the present essay is to explore in an informal manner a new, game theoretic account of equity.[1] In presenting the new theory, particular emphasis will be placed on the interrelationships that exist between game theory, decision theory, and social choice theory in the context of alternative theories of equity. As a result of our research, the reader's understanding of the concept of "fairness" should be deepened--in applications ranging from negotiation theory to abstract moral theory.

There are three salient features of the proposed theory. First, it integrates into a coherent whole two ethical subtheories. These subtheories reflect a concern with two differing concepts of distributive justice: allocation according to relative need and allocation according to relative contribution. Moreover, each subtheory is given an unambiguous game theoretic characterization. Second, the theory incorporates a new concept of impartiality that is inspired by and congruent with the concept of relative needs and that dispenses with the concept of rational choice under uncertainty. Third, although the theory makes an essential use of interpersonal comparisons of utility at a conceptual level, it does not entail such comparisons at an operational level.

In Section II, the reader is furnished with an overview of the basic structure of the new theory. In Section III, the subtheory of distribution according to relative needs is developed. Here attention is drawn to the mathematical equivalence of the ethical model developed in this theory with the Nash-Harsanyi theory of pure n-person bargaining games and with the Kaneko-Nakamura version of axiomatic social choice theory. In Section IV, the subtheory of distribution according to relative contribution is discussed. And Section V presents an informal characterization of a two-stage game, which when played, will realize "full distributive justice" as understood in the new theory.

II OVERVIEW OF THE THEORY

On a rather broad level, the theory is based on my belief that two quite different yet equally compelling concepts of distributive justice exist: allocation in accord with relative need (RN) and allocation in accord with relative contribution (RC)[2]. A dual purpose of the theory is to provide a satisfactory characterization of each of these two norms and to demonstrate their proper interrelationship. The first of these tasks will be addressed in the next two sections of this paper. It is the latter task that is addressed in the present section.

For purposes in the present paper, it is simply assumed that there are two fundamental distributive norms, namely, the RN and RC norms just mentioned. Let us introduce alongside of these norms two different kinds of environments: manna and nonmanna environments.[3] A <u>manna environment</u> is defined here as an environment in which people do not have differential claims on the social product that are due to differential contributions to production of the product. For example, consider the case of two children who wander into the kitchen and find an apple pie on the kitchen table, --a pie which neither has baked or bought. Then it seems reasonable to view the pie as "manna from heaven" as far as the two children are concerned. Accordingly, they (or their guardian) face a manna distribution problem. This situation can easily be distinguished from a nonmanna distribution problem which will arise if one or the other--or both--of the children have produced the pie.

Now even though it would seem appropriate to invoke some needs-oriented allocative principle in a manna distribution problem, it is not prima facie clear what type of principle should be adduced in a nonmanna situation. By demonstrating that a particular <u>dependence condition</u> can obtain between the RN norm and the RC norm, I hope to make a case that it is ethically respectable to appeal to a principle of relative contribution (RC) in certain nonmanna situations.

II.A The Basic Setup

The introduction of the basic setup underlying the theory will make it possible to establish the mesh between the two fundamental distributive norms. Assume that n people exist in some hypothetical society. Each of these n people is assumed to have (cardinal) preferences represented by means of a von Neumann-Morgenstern utility function. Whether and in what form interpersonal utility comparisons arise will be made clear in the sequel. References in this paper to a game or an arbitration problem will mean that the decision problem in question is one of complete (if imperfect) information. Morever, it is assumed that any given game has a unique solution, e.g. the "traced" equilibrium point of the recent Harsanyi-Selten theory [Harsanyi (1975)].

The basic analytical tool in the proposed theory is a <u>two-stage decision problem</u>, denoted by G^*. For the moment, G^* is discussed in an informal manner. This discussion will be supplemented by Section V. where G^* is characterized as a particular two-stage game in which the prizes of the first stage are a set of second-stage games. In Stage I of the decision problem, a constitution must be chosen. This constitutional choice decision problem is denoted G^c. The <u>choice set</u> of G^c is simply the set $P(c)$ of all probability mixtures of the alternative possible constitutions. The set of alternative possible constitutions is denoted C. The discussion below shows how game theory can be used to characterize C in an unambiguous way.

Now choice of some constitution $c \varepsilon C$ is thought to induce an associated second-stage decision problem G_c. The basic idea here is that a constitution serves partially to define the decision problem with which we are confronted in daily life. The choice set of the Stage II-decision problem can thus be thought of as the set of all possible constitutionally admissible "life-plans"--to use a Rawlsian phrase--from which the citizens can choose. This set of admissible life plans will depend upon the constitution c chosen in the Stage I-problem G^c.

The payoffs in G^c and G_c are interdependent in the following sense. The payoff n-tuple generated in G^c by choice of some constitution $c \varepsilon C$ is assumed to be the payoff n-tuple awarded the citizens by participation in the c-induced decision problem G_c played in Stage II of the two-stage problem G*. This interdependence is schematized in Figure I where such notation as is introduced should be self-explanatory.

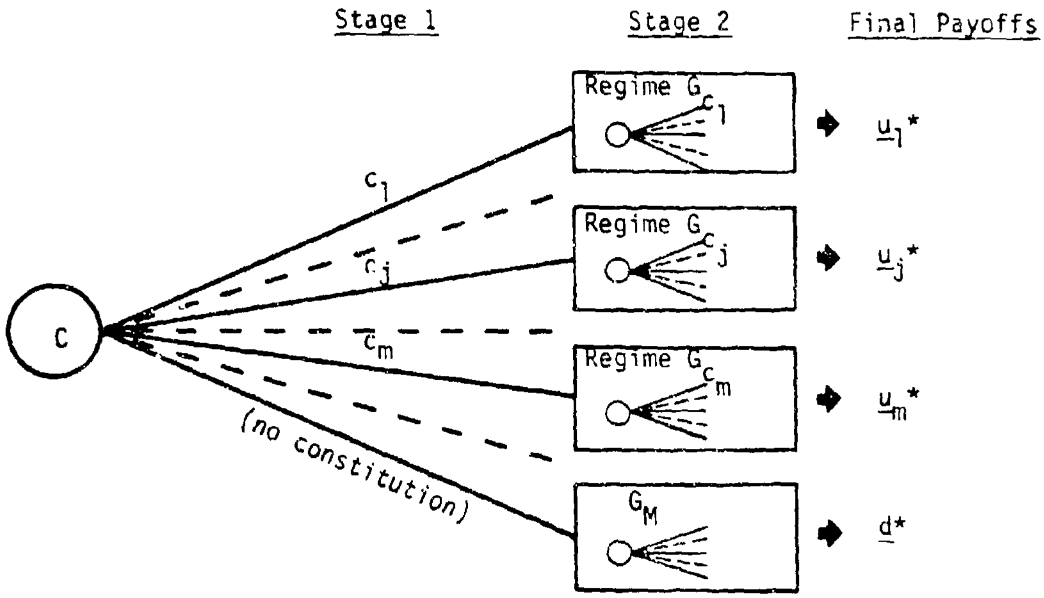


Figure I

A question arises as to the circumstances under which the Stage I decision problem G^c is meaningful. Why would the n citizens ever consider participating in a constitutional choice problem? We introduce the familiar assumption in this context that all n citizens can improve their prospects by agreeing to participate in G^c. (Because of the utility gains which can be sponsored by side-payments in most real-world situations, this assumption is not regarded as very severe.)

More specifically, if the citizens do not participate in G^c, or if they fail to reach agreement in G^c on some constitution, then they will by assumption participate in a default decision problem G_M whose payoff n-tuple is dominated by the payoff n-tuple of at least one (and presumably many) constitutional regimes G_c. In short, the citizens have an incentive to reach an agreement in G^c. All will gain by doing so. The payoff from G_M will be denoted by d^*, and can be thought of as the zero point of the constitutional decision problem G^c.[4]

II.B The Role of the Two Distributive Norms

The Stage I decision problem G^c can be interpreted as a manna distribution problem whereas the Stage II decision problem can be interpreted as a nonmanna problem. Participation of G^c amounts to an act of constitutional deliberation. If, as seems reasonable, we assume that all n citizens are "equal" in these deliberations in the sense of being guided by the same principles of rational choice or ethics, then no one can really be said to contribute more than anyone else. Participation in G^c is in effect a luxury which no one has earned or brought about.

But the situation is clearly different in the Stage II problem G_c. Here different people will adopt different life plans, will utilize their differing talents differently, and will generally contribute differentially to such social product as is produced.

Our fundamental proposition is that (i) the decision problem G^c should be solved (i.e., played/arbitrated) on the basis of a theory of relative need, and (ii) the Stage II problem G_c should be solved on the basis of a theory of relative contribution.

The intuitive justification for (i) is straightforward. Any satisfactory theory of manna distribution will at some level or other be based upon the concept of relative needs.[5] The intuitive justification for (ii) is trickier. Many philosophers feel that the contribution principle has less status than the needs principle. Rawls (1971, 305-309) would seem to share this view, although he never clarifies the relationship between the two norms. Our view is that both norms are fundamentally important. However, for the contribution principle to be applicable in a given decision problem, the overall environment in the decision problem must be ethically respectable. Specifically, for the contribution principle to apply in G_c, the constitution c that induces

G_c must have been chosen in the prior problem G_c on the basis of relative needs. In short, both norms are indispensable; but there is a specific dependency condition which relates the two norms in a critically important way.

A simple example might help at this point. Suppose that it is generally agreed that the "basic institutions" of our society are just. For example, they were selected on the basis of some impartial and needs-respecting process. Under these circumstances, how do we react if a very able, hard-working and contributory junior faculty member is refused tenure, whereas a less talented and contributory person receives tenure? Surely our sense of justice is offended. Specifically, our sense of "to each according to his contribution" is offended. The question of the relative needs of the two teachers is not likely to arise at all! Yet despite this reality, most contemporary theories eschew the norm of relative contribution.

Fundamental Defintion: We shall say the Full Distributive Justice obtains if G^c is solved in accord with the needs criterion, and if G_c is solved in accord with the contribution criterion.

Two brief comments are in order at this point. First, we have not defined allocation according to "needs" and "contribution." This will be dealt with in Sections III and IV. Second, we have not made clear what is meant by a decision problem that must be "solved." Precisely what kind of a procedure can be used to solve the two-stage decision problem G*? This matter is dealt with in Section V. In the remainder of the present section, we wish to discuss the role of the default game G_M in the proposed theory of justice.

II.C The Zero Point and the Nature of the Choice Set C

The decision problem G_M is important in the theory for two different reasons. First, the payoff n-tuple from this problem will affect which constitution is selected in the Stage I problem G^c. The reason for this is simply that this payoff serves as the zero point (status quo point) in the constitutional choice problem G^c, and the welfare function to be used in solving G^c is sensitive to the zero point. We do not regard this last consideration as problematic. First, any coherent theory of allocation according to relative need will necessarily depend upon the zero point, as we attempt to demonstrate in Section III below. Second, the proper (and meaningful) domain for a theory of distributive justice is the set of gains which accrue from adoption of a set of basic institutions [e.g. Rawls (1971, 7)].

The second reason why the default game G_M is important in the theory is that it is used to provide a formal characterization of the choice set C of the constitutional decision problem G^c. Hitherto, it has never been quite clear what a "constitution" or set of "basic institutions" is. In the new theory, game theory is used to provide an unambiguous description of C. Let us take this opportunity to sketch how this works.

Rawls (1971, 55) defines a constitution as

> ... a public system of rules which define offices and positions with their rights and duties .... These rules specify certain forms of actions as permissible, others as forbidden, and they provide for certain penalties.

This intuitively appealing definition can be modeled game theoretically in the following way. Recall the G_M is the game which will be played if no constitution is adopted in the decision problem G^c. In G_M it is reasonable to suppose that "anything goes." Specifically, the strategy set of G_M is <u>maximal</u> in the sense that it encompasses all and any physically feasible behavior. To state this is to make a descriptive statement about what is physically <u>possible</u> in G_M, not a normative statement about what it would be individually or jointly <u>rational</u> to <u>do</u> in G_M. Let us couple this observation with an argument that has been developed elsewhere [Brock (1978)]. The gist of this argument is that it is possible to identify the set of all possible <u>restrictions</u> on physically possible behavior with the various components of Rawls' definition of a constitution, to wit (i) prescriptions of certain actions; (ii) proscriptions of certain actions; and (iii) adoption of specific penalty and reward systems. What we end up with is the realization that the set C of constitutions can be viewed as the set of all possible <u>strategy restrictions</u> of G_M. Choice of a given constitution c will induce a strategy restricted version of G_M, namely the Stage II regime G_c.

III ALLOCATION ACCORDING TO RELATIVE NEEDS

The concept of distribution according to relative needs is as ubiquitous as it is ambiguous in ethical theory. Rawlsians, utilitarians, and Marxists attempt to show that their theories are consistent with some needs principle. The reason for this surely lies in the fact that the concept of needs is the most familiar and appealing of ethically respectable distributive principles. And yet in our opinion, no particularly compelling or unambiguous theory of needs allocation has been set forth. In Part A of this Section, we shall sketch what we believe to be a satisfactory needs theory. In Part B of this Section, this theory will be contrasted with the treatment of needs in the utilitarian and Rawlsian theories.

The role of the needs theory in our overall theory of justice is to provide the basis for a solution to the constitutional choice problem G^c. Recall that this problem is being interpreted as one of manna distribution and therefore calls for a needs-oriented solution concept. In the present Section, we shall suppress any further reference to G^c and shall motivate the needs subtheory by means of some very simple examples.

III.A A Theory of Distribution According to Relative Needs

Consider a simple two-person pie division problem. The prospect space consisting of all feasible utility n-vectors (with n = 2 now) for such a problem is sketched in Figure II. It is assumed that the two utility functions have been interpersonally calibrated with respect to both the origin and the unit of the utility functions. Later it will become clear in what sense--and why--this assumption can be discarded, at least at an operational level. The origin of the prospect space U will be denoted by the vector d, and is assumed to correspond to the "no pie" outcome. Note that the Pareto boundary in Figure II is flat.

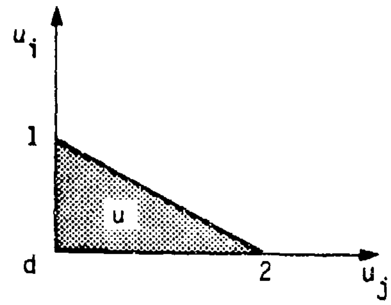


Figure II

We have intentionally started off with this special case.[6] When there is a flat boundary, there is an unambiguous measure of relative needs. This is the slope of the Pareto frontier. In the present example, player j gets 2 units of interpersonally calibrated utility for every unit that i gets--i.e., j is twice as needy. Of course, in asserting this, we are in effect equating "relative needs" with "relative intensity of desire." This seems unobjectionable since our concern is with relative--not absolute--needs.

To determine an allocation of pie that corresponds to the relative needs of i and j, we introduce our fundamental norm of equitable manna distribution according to relative needs:

Postulate A: The Proportional Priority of Preference Postulate (PPPP): Pie should be distributed such that the utility gains to the recipients are proportional to their relative needs. Formally

$$\frac{u_i - d_i}{u_j - d_j} = \frac{a_j}{a_i} \qquad (1)$$

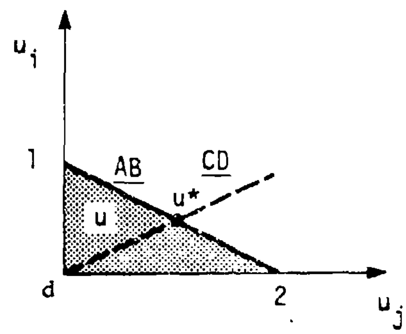
where the variables a_i, a_j correspond to the slope of the Pareto frontier. In the present case, we require that $a_j/a_i = 1/2$.

The PPPP in and of itself is not sufficient to determine a unique solution to the problem. For if the reader will consult Figure III, he will observe that any and every point on the line CD satisfies (1). Therefore, we supplement PPPP by a straightforward

Postulate B: Efficiency: The pie must be distributed in such a way that an efficient (Pareto optimal) outcome is achieved. Formally, we require

$$\max_{U} \sum_{k} a_k u_k \qquad k = i,j \tag{2}$$

Note that this is not the ordinary efficiency condition. For the a_k here are not variables, but are the given slope values, a_i, a_j.



The equation of CD is (1) above;
The equation of AB is $\sum a_k u_k = c$ (where c is a hyperplane constant)

Figure III

Choice of any other values for these weights would clearly render (2) incompatible with (1). Taken together, (1) and (2) clearly define a unique solution to the distribution problem, namely a utility vector u* lying midway along the Pareto frontier. At this point, i receives a utility gain 1/2 as great as j receives, which seems reasonable since i's need is half as great as j's. Geometrically, u* is the point of intersection of the two lines AB and CD which have the property that their slopes are equal in magnitude but opposite in sign.

Three comments are in order. First, our PPPP makes clear that it is utility and not pie that is fundamental in the theory. Pie is only important because it generates utility, i.e. fulfills human needs. And to the extent that "something" must be mathematically allocated in proportion to needs, it is utility, not pie.

Second, the above formulation falls somewhere between the Rawlsian and the utilitarian formulations. This can be seen from two vantage points. To use S. Strasnick's terminology, in the case of utilitarianism, no one has Priority of Preference. Everyone's wants enter on an equal footing. In Rawlsian MAX MIN type theories, the worst off person's needs receive absolute priority. In the proposed theory, priority is distributed in proportion to relative needs. This comparison on the basis of preference priority is mirrored by differences in the weights which characterize the welfare functions of the three theories. Note in particular that whereas the weights in the utilitarian and Rawlsian welfare functions are constant, the weights a_i and a_j appearing in (2) above will vary according to the distribution of needs in a given problem.

Third, the proposed theory embodies a form of impartiality that is significantly different from that of rational choice under uncertainty (e.g., Veil of Ignorance impartiality). At this point in the paper, we shall simply introduce the new concept of impartiality. In Section III.B., we will contrast it with the other concept and defend it. Let us suggest that a decision is impartial in an ethical sense if the only information used in arriving at the decision is ethically significant information. In a manna distribution problem, this translates into the condition that the decision must be made solely on the basis of relative need. For example, an ethical decision maker will not be influenced by how physically attractive person i is relative to person j, or by his own personal preferences for i and j's personalities.[7]

An ostensible limitation of the foregoing account is that it assumes a "flat" Pareto frontier in order that a well-defined measure of relative needs exist. In general, the Pareto frontier will not be flat, but will be strictly (or at least piecewise strictly) convex. Fortunately, the proposed theory goes through in this more general situation. The reader can convince himself that when the boundary of U is strictly convex, there is once again a unique solution to (1) and (2). See Figure IV for

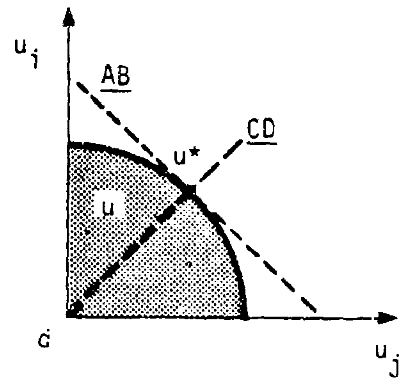


Figure IV

a schematization. There are two salient differences now, however. First, it is no longer meaningful to suppose that the efficiency condition (2) "supplements" (1). Rather both conditions enter on equal footing, and the values of the variables a_i, a_j as well as of the payoffs (u_i-d_i), (u_j-d_j) are determined simultaneously when (1) and (2) are solved. This is to be contrasted to the earlier case where the values of a_i and a_j were known from the outset. A second difference is that whereas we originally had a global measure of relative need, we now have only a local measure, namely the slope of the line AB tangent to the solution u*. However, we can justify an identification of this local measure with a global measure on the following grounds. For any and every strictly (or piecewise) convex problem U there will be a unique flat problem $\bar{U}$ constructed as follows. Simply replace the original problem U with the problem $\bar{U}$ whose prospect space is the set of utility vectors bounded by the line AB which is tangent to the solution u* to the original problem. This flat problem $\bar{U}$ will clearly have the same solution u* as the original convex problem, so that the two problems can be deemed solution equivalent. And the measure of relative needs in both problems will clearly be the same, namely the slope of the line AB. We can therefore let this slope serve as a global measure of relative need in both U and $\bar{U}$.

Note the important role of the disagreement payoff d in the proposed theory. The solution a* and u* to (1) and (2) clearly will depend upon the parameter d. To point this out does not prejudge whether there exists a meaningful zero point in a given problem. Often there will not be one. However, what this does suggest is that _if_ we want an ethical theory that is firmly based upon an unambiguous account of relative needs, then a zero point will _necessarily_ enter into the matter at some point.[8]

It is now time to state one of the more interesting facts about the theory of manna equity that has been sketched. The theory turns out to be intimately related both to the axiomatic theory of bargaining, and to the axiomatic theory of Arrowian social choice. Loosely, we have a

Fundamental Correspondence Theorem: The ethical theory of manna distribution sketched above is fundamentally different from the Nash-Harsanyi theory of bargaining, and from the Kaneko-Nakamura account of social choice theory in a cardinal utility context. Nonetheless, the three theories are _solution equivalent_ in the sense that they will always imply the same physical solution to a given problem.

No formal proof of this result will be given here [see Brock (1978)]. However, we shall provide an informal motivation and justification for the result. The manna theory proposed above is properly speaking a contribution to ethics and welfare economics--not to means-ends rational choice theory as we ordinarily think of the latter. Harsanyi has insistently and rightly pointed out the need to separate these two sets of concerns [e.g., Harsanyi (1961)]. Now the purpose of the proposed theory is to characterize distributional equity in terms of the players' relative needs. Accordingly it was both necessary and meaningful to introduce interpersonal comparisons of utility. Or to state the matter differently, it would have made no sense to have introduced a game theoretic (or social choice theoretic) postulate of invariance under separate transformations of the players' utility functions. For the relative needs of a given pair of players in a given situation can only be represented by a _single needs ratio_ which will clearly depend upon the calibration of the utilities.

The situation is completely different when we turn to bargaining theory. Here interpersonal comparisons are not necessary because (i) the focus is on the question of rational strategic behavior--not on a fair distribution of utility; and (ii) it is possible to characterize rational behavior in terms of certain dimensionless numbers that Harsanyi (1977a) has called the players' risk limits and that are invariant under separate transformations of the players' utilities.

And yet it happens that the solution prescribed by the Nash-Harsanyi theory (i.e., maximize the product of the utility gains) can be restated in the form of equilibrium conditions that are mathematically identical to our conditions (1) and (2) above! Note what this implies. Since the Nash-Harsanyi theory is (intentionally) invariant under linear transformations separately of the utilities, we will always get one and the same physical solution (pie distribution) for all admissible choices of the utility scales, including the "true choices" that correspond to the interpersonally calibrated representations of the utilities. Hence, the Nash-Harsanyi theory and the proposed manna theory are solution equivalent, as asserted above. The same type of reasoning can be used to demonstrate the equivalence of our manna theory and the Kaneko-Nakamura Theory of Social Choice.[9]

This result is interesting for several reasons. First, it establishes an interesting link between game theory on the one hand and ethics on the other hand. Let us explore this and in doing so attempt to provide a new interpretation of the Nash-Harsanyi theory. L. S. Shapley (1969) aptly observed that bargaining by its very nature tests the players' relative intensity of desire for what is at stake. Hitherto it has not been possible to make precisely clear what this observation amounts to. The reason why this is so is that virtually all discussions (including Shapley's) take place within the confines of an invariant theory which rules out interpersonal comparisons. Our analysis above puts things in a different light.

We can suppose that we do know the true, interpersonally calibrated scales of i and j. With these in hand, we can reason that a given pure bargaining game the players will reach an equilibrium that will distribute utility (fulfill needs) in strict proportion to relative needs. Specifically, we might expect a utility payoff satisfying our equilibrium conditions (1) and (2) above. Finally, we note the "solution equivalence" between this theory and the Nash-Harsanyi theory. We have in effect used the assumption of interpersonal comparisons to provide the basis for an alternative account of the Nash-Harsanyi theory.[10]

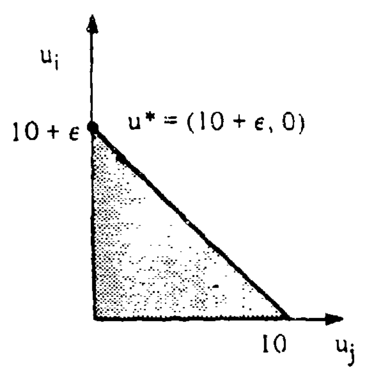
The fact that the Nash-Harsanyi theory is invariant under separate affine transformations of the utilities can be interpreted in the present context as follows. We can construct two games A and B with the following properties. The players in A have interpersonally calibrated utility scales that are nontrivial affine transformations of those of the players in B. Hence the distribution of "needs" in A is <u>different</u> from that in B. However, due to Nash invariance, the physical payoff (distribution of pie) will be the <u>same</u> in A and B. Is this troublesome? Not at all. For the bargaining theory we have sketched takes the distribution of utility--not of pie--as fundamental. And clearly the distribution of utility awarded by the Nash-Harsanyi theory in games A and B <u>will be different</u>--with the difference mirroring the difference in the distribution of needs within the two games.

A second interesting consequence of the Correspondence Theorem lies in its implications for abstract social choice theory. In a recent article reviewing some interesting developments in axiomatic social choice theory, Kenneth Arrow (1978) argues that the use of interpersonal comparisons is problematic in constructing a satisfactory theory of social choice. On the other hand, he feels that a satisfactory welfare function will possess certain continuity properties which presuppose cardinal utility. Apparently, therefore, he would like a theory which makes use of cardinal utility but which dispenses with interpersonal comparisons, at least at an operational level. The theory we have proposed would seem to meet these desiderata. So does the Kaneko-Nakamura theory.

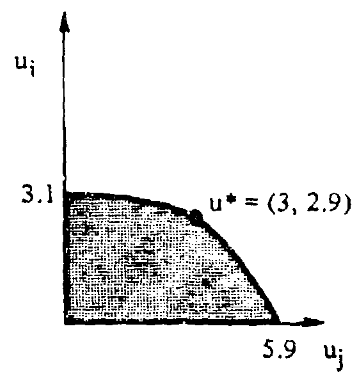
III.B A Comparison with Other Ethical Theories

We shall now offer a few comments about the role of the concept of relative need in the utilitarian and Rawlsian theories. Thereafter in III.C we shall contrast the concept of impartiality embodied by our theory with that of the Rawls-Harsanyi Veil of Ignorance concept. In so doing, we shall offer a fresh criticism of Bayesian rationality postulates in ethics.

Consider from a utilitarian standpoint the dilemma of a parent who has to give a present to either of two children. In the case depicted by Figure V.A below, the present--and <u>all</u> the utility at stake--will go to child i whose need is ever so slightly greater than j's need. In this <u>type</u> of situation, it can in some sense be asserted that utilitarianism sponsors allocation in accord with--but not "in proportion to"--relative need.



<u>Figure V.A.</u>



<u>Figure V.B.</u>

Next consider a pie division problem giving rise to the prospect space of Figure V.B. Utilitarianism here will award slightly <u>more</u> utility to child i than to child j. But can we now claim that i is needier than j? Not really, for if all the pie went to i he would only get about one half of the utility that j would get. Finally, in cases like V.B where corner solutions do not occur, the utilitarian solution clearly will occur at the point of tangency between the iso-utility contour of the utilitarian welfare function--namely the straight line with a -45° slope--and the Pareto boundary of the set U. At this point, the needs of the players are equally <u>urgent</u>. This of course is merely a <u>local</u> property of the solution in this case (compare Figure V.A), and it contrasts with the global situation in Figure V.B which is not one of equal needs. As a result of these observations, we do not believe that utilitarianism can meaningfully be held to distribute utility in accord with any coherent theory of relative need.

The concept of relative needs plays an important role in Rawls' derivation of the Maximin principle. However, Rawls is not always clear, and for our present purposes we shall draw upon S. Strasnick's (1975) social choice theoretic axiomatization of the lexical maximin principle to criticize the role of needs in maximin-type theories. Strasnick's fundamental theorem is that if ordinal interpersonal comparisons are admitted, and if the social choice function satisfies certain plausible axioms of independence, impartiality, and unanimity, then it must be either a lexical maximax or a lexical maximin decision procedure. Which of these two welfare functions will obtain depends upon which of two parts of a certain lemma we _choose_ to adopt. The lemma is called the _extended decisiveness lemma_ and states: For all x_i, y_i, y_j, x_j _either_

(a) $x_i > y_j \rightarrow xP_iy > yP_jx$; or

(b) $y_i < x_j \rightarrow xP_iy > yP_jx$.

Here x and y refer to alternative social states. i and j index the citizens. x_i refers to the position of being i in state x, etc. Finally, P is the standard social preference relation. In commenting upon the choice that we must make between part (a) and part (b) of his lemma, Strasnick says:

> ... we must choose whether one individual's preference will have a greater priority than another's whenever he would be left worse-off than the other if his preference were frustrated--or whenever he would be left better-off if his preference were satisfied. Ultimately, this choice must depend on which component of the individual's preference must determine the status of his preference's priority--his preferred state, or his non-preferred state. Since the individual's condition in his non-preferred state is associated with the nature of his needs, the maximin SCF may be conceived as preferring the same state as the individual with the greatest needs. If we believe that the status of an individual's needs are relevant to the social choice, then we should be prepared to adopt as one of the constraints on the SCF the condition ruling out the legitimacy of part (a) of the extended decisiveness lemma. This would, in fact, be a natural condition if we held the task of social

choice to be the distribution of scarce resources among conflicting needs--a task for which the maximin SCF is, some would think, well suited.

We have two problems with Strasnick's insightful account of this matter. First, it seems peculiar to define need in terms of a person's non-preferred outcome. Game theoretic reasoning suggests why this is so. Both Strasnick and we take people's preferences--i.e. their utilities--as fundamental. To speak of a person's being in his worst off state can be translated into his being awarded the utility payoff corresponding to that social state. Now in a constitutional choice problem, it surely seems reasonable--and it is physically possible--for the participants to adopt a jointly randomized strategy if need be. The ability to achieve an <u>efficient outcome</u> (in utility space) by this means insures from the outset that <u>no one will receive his lowest possible utility level</u> in an ex ante sense. This being the case, it is not clear why we would ever wish to conceptualize needs in terms of how badly off the worst off person could be. Should we not rather identify needs with the improvements in everyone's well-being which adoption of a constitution will sponsor--with what is in fact at stake in the decision problem? This is of course our approach to the matter.

Our second problem with Strasnick's approach is the requirement within his setup for someone to have to have "preference priority," that is, to be an Arrowian dictator. Analytically this requirement is a natural consequence of a setup that rules out cardinal utility, as Arrow (1978) and Sen (1977) have pointed out in different ways. If cardinal utility is needed for the SCF to possess the continuity properties that permit social welfare to be defined as a reasonable "balance of advantages" among <u>all</u> citizens, then enter cardinal utility. Both the utilitarian theory and our theory are cardinal in nature.

III.C <u>On the Concepts of Relative Needs and Impartiality</u>

We shall conclude this section with a brief discussion of two alternative concepts of impartiality and their relationship to the concept of allocation in accord with relative needs. Let us suggest that there are two somewhat related but essentially different concepts of a decision that is impartial in an ethical sense of the term. First, there is the concept of an ethical decision as a rational decision that is made by a rational person who is impersonally situated. This is of course the concept of impartiality adopted by Harsanyi (1953) and Rawls (1971).

Second, there is the concept of an ethical decision as the decision that will be made by a person who is impartial in the specific sense that he will only take ethically significant information into account in reaching his decision. Specifically, in a manna distribution problem, he will take account of the players' differences in needs--but that is all. He will not be biased by considerations of how attractive or intelligent they are, much as these other considerations will affect his behavior when he is not acting in an impartial manner. This second concept of impartiality is consistent with our manna theory. It is also fully consistent with the tradition of impartial sympathetic humanism which Harsanyi himself (1958) finds so appealing.

Which of these two concepts is the more appropriate on which to found an ethical theory? In answering this question, I wish to join Harsanyi (1961) in insisting on the importance of separating questions of ethics from questions of rational behavior. The two are very different and must not be confused. And yet, they have been confused in the Rawls-Harsanyi concept of an ethical decision as a decision that an impersonally situated rational individual would make. Let us expand upon this point.

The purpose of an ethical theory of distributive justice is to characterize equity, not to serve as the vehicle for an application of rational choice theory. However, if rational choice theory can increase our understanding of equity, then so much the better. But the link between ethics and rational choice theory must be made very clear, and the proper role of rational choice theory in serving ethics must be demonstrated, not assumed. Specifically, the decision to use certain axioms of rational choice theory as a foundation for ethics must be justified. And such counterexamples as arise from doing so must be explained. Harsanyi (1975a) has criticized

Rawls on both these grounds, and we propose to sketch a brief criticism of his own theory along similar grounds in defense of our theory.

First, we shall discuss the legitimacy of Harsanyi's use of certain rational choice axioms in an ethical theory. In a recent (1977b) paper, Harsanyi gives a characteristic defense of the three axioms he originally introduced in his landmark 1955 paper:

> Axiom (a) (Individual rationality) is an obvious rationality requirement. So is also axiom (b) (Rationality of moral preferences): it expresses the principle that an individual making a moral value judgment must be guided by some notion of social interests (public interest), and indeed, must act as a guardian of these social interests; yet when anybody acts as a guardian of social interests, he must follow, if possible, <u>even higher standards of rationality</u> than a person who is merely pursuing his personal interests. Thus if rationality requires that each individual should follow the Bayesian rationality postulates in his personal life as postulate (a) implies, then he must even more persistently follow these rationality postulates when he is making moral value judgments.
>
> [Harsanyi (1977b,9)]
> (emphasis added)

We are told that a person who wishes to make ethical decisions--that is, decisions which are in the social interest--must follow the highest possible standards of rationality.[11] But neither here nor elsewhere are we told why this is so. Why should a person such as a public official who is charged with acting in an ethical and fair manner follow standards of <u>rationality</u> as opposed to compelling standards of <u>equity</u> such as "To Each According to His Needs?" This is never explained.

Now if rational choice arguments such as Harsanyi's contributed to the characterization of an intuitively compelling theory of equity then, as we have said above, so much the better. But as we have already argued in Section III.A above, the utilitarian theory is not congruent with our moral intuitions concerning the concept of distribution according to relative needs. Indeed, utilitarianism gives rise to counterexamples such as that appearing in Figure V.A above where a person who has an ever so slightly greater need for pie than another person receives all the pie (and hence all the utility) at stake.

In the foregoing discussion, we have focused on Harsanyi's deductive, axiomatic derivation of utilitarianism. We chose this model because it provided the opportunity to express certain doubts about the role of rationality postulates in ethics proper. But Harsanyi has another model, a constructive model in which he derives utilitarianism as the solution to a single person decision problem under uncertainty [e.g., Harsanyi (1953)]. In this landmark paper, Harsanyi uses rational choice theory once again. But his use of it here differs from that above. He simply defines an ethical decision as an impartial one, where by impartiality he means impersonal rationality. The thrust of our above remarks carries over to the present context. Once again, to the extent that rational choice theory is used to derive an ethical theory that is neither needs-respecting nor free from serious counterexamples, there is a problem. For as we have already said, rational choice theory should only enter into ethics to serve ethics.[12] Above and beyond this, there does exist an alternative concept of impartiality that conforms quite well to our instincts about allocation is accord with relative needs. This alternative concept is embedded in our theory.

IV ALLOCATION IN ACCORD WITH RELATIVE CONTRIBUTION

In Section II, we suggested that full distributive justice would entail the use of the contribution norm in the Stage II decision problem, namely, the regime G_c in which people actually choose and live out their life plans. We shall now discuss very briefly how game theory can provide an analytical basis for the ambiguous concept of allocation according to relative contribution.[13]

Most scholars would probably argue that economic theory has helped illuminate the concept of relative contribution. According to the marginal product theory of general equilibrium analysis, each factor (specifically, labor) is paid a dollar amount equal to its dollar contribution to the organization employing it. Two fundamental problems with this doctrine prevent its application in an ethical context. First, the theory holds only in the context of perfectly competitive economies. Our regime G_c may well have an economic system of some sort associated with it; but it will surely entail social systems other than the market, e.g., the family and the polity. Second, the economic theorem states that the dollar value received will equal the dollar value of contribution. But we are interested in <u>utility</u>, not dollars, and since people do not all have the same marginal utility for dollars we cannot identify money and utility. Game theory now comes to the rescue and alleviates <u>both</u> these problems.

Our basic tool will be the concept of the <u>nontransferable utility Shapley Value</u> of a game, henceforth referred to as the value. This solution concept was introduced by Harsanyi (1963) and refined by Shapley (1969). The Shapley Value payoff to player i in an arbitrary n-person cooperative game is

$$\left\{u_i = \sum_S \nabla\,[V(S) - v(S - \{i\})]\right\}_\lambda \qquad S \subset N \qquad (3)$$

where:

λ is the n-vector of equilibrium "game weights" (defined below);
∇ is the generalized expectation operator $[(s-1)!(n-s)!/n!]$ in which
s is the cardinality of a given coalition S of players,
n is the cardinality of the player set in the game;
S denotes an arbirtrary coalition;
N is the player set; and

v(S) is the so-called characteristic function of the game. Loosely this is a real-valued set function which specifies the "worth" of any coalition $S \subset N$. More formally, v(S) is the sum of the utility payoffs to the s members of S when the coalition plays its "optimal" strategy in opposing the complementary coalition N/S.

To motivate the concept of the Value of a game, let us first consider the expression that lies within the outer brackets of (3). That is, ignore the entity λ. We can see here the sense in which the Shapley Value of a game to player i provides a measure of a player's contribution to the players in game. The expression within the inner brackets is clearly a measure--in utility units--of the contribution that player i makes to the coalition S. Now clearly this utility contribution will depend upon S and upon the order in which the various possible coalitions S form. This is the reason for the operator ∇. This expectation operator stipulates that in calculating the contribution of i to the various possible coalitions, all orders of coalition formation are assumed equally likely. The Shapley Value is then defined as the sum of i's contribution to all possible coalitions S, averaged over all possible order of coalition formation. Clearly, the player who receives as his payoff from a game his Shapley Value of the game can be said to be receiving his net contribution (of utility). In short, the Value respects the contribution principle.

In all but a very few special cases (e.g., the case of games with "side-payments") the Value of a game will not exist. However, the Value will always exist provided that each person's utility scale is weighted by an equilibrium utility weight. Thus, the symbol λ appears outside of the outer brackets. Determination of the "proper" vector of weights is a complex mathematical question we shall not discuss. However, we shall briefly discuss the meaning of the Value in light of the need to multiply each person's utility scale by an appropriate weight.

To understand the meaning of the Value in the presence of the utility weights, it will be helpful to introduce the assumption that the utility functions of the players have been interpersonally calibrated with respect to both unit and scale. This assumption is not at all necessary for game theoretical analysis. However, we believe it is necessary if we are to come to an understanding of the Value suitable for ethical analysis. Suppose now that the game in question has been solved for its Value. Suppose moreover that for the particular game in question, $\lambda_1 = \lambda_2 = \ldots = \lambda_n$. In this very unusual case, we know from (3) above that the unweighted utility payoff to player i will be equal to his average net contribution to N as measured in unweighted and interpersonally calibrated utility units. The reason for this is that we can set $\lambda_i = \lambda_j = 1$ with no loss of generality. In this case, the meaning of the Value of the game is crystal clear. In general, however, we are confronted with a situation where the Shapley Value formula appearing within the outer brackets of (3) will only obtain if each person's "true" (i.e., interpersonally calibrated) utility function is rescaled by his utility weight. It can be shown [Brock (1978, 1978c)] that the equilibrium utility weights are coefficients of relative need representing the differences among the players in relative intensity of desire for what is at stake above and beyond the threat payoff of the game.[14] In short, the Shapley Value awards player i a needs-weighted utility payoff equal to his average contribution of needs-weighted utility to the other players.

The implications of all this are interesting for ethical theory. Two avenues are open to us. First, we can be quite loose in our interpretation of the contribution norm and hold that if the solution to a given competitive decision problem is the Value of the problem, then each person is "receiving" what he has "contributed," and the contribution principle is being respected. Second, we can take a much more puristic stance and assert that the only situation where the contribution norm is being respected is the situation where the utility weights are all equal (relative to the set of interpersonally calibrated utility scales). For our present purposes, we shall adopt the first interpretation here, though not without some hesitation.

For the purposes of our ethical theory, there is one more point to be made about the Shapley Value concept. This concerns its realization in a surprising number of economic and political models of competitive behavior. Harsanyi (1963) formulated a pluralistic bargaining model of social behavior and showed that his bargaining solution would always be a Shapley Value of the underlying game. Aumann (1975) showed that in certain classes of exchange economies, competitive market trading would realize the Shapley Value. Finally, Aumann and Kurz (1977) have constructed a "mixed" model incorporating both market trading and legislative (voting) behavior and have characterized the solution to their model as a Shapley Value. In short, a variety of models of competitive behavior realize the Value and hence realize distribution in accord with relative contribution. The situation is analogous to that in Section III where we observed that rational behavior in a "pure" bargaining game will realize distributional equity in the sense of relative needs.

V REALIZATION OF FULL DISTRIBUTIVE JUSTICE VIA A CONTRACTARIAN MODEL G^*

Our results put us in a position to characterize full distributive justice (as defined in Section II.C above) in terms of the play of a two-stage game G^*. It will probably help the reader here to consult Figure I. The first-stage game is an n-person pure bargaining game G^c. The disagreement payoff in this game is the payoff d^* awarded in the game G_M. G_M it will be recalled is the default game in which the players will participate if they cannot reach unanimous agreement in G^c on the choice of an optimal constitution c^*. The prizes at stake in G^c are all (joint randomizations of) the alternative possible constitutions $c \varepsilon C$, or equivalently the regimes $\{G_c\}$ induced by adoption of the various constitutions. The stipulation that G^c be a pure bargaining game ensures that the "needs principle" is being respected in its proper domain.

The second-stage component game of G^* is simply the regime G_{c^*} chosen as the solution to the Stage-I problem G^c. The strategies of G_{c^*} lead to an outcome that is a Shapley Value of the game. For when this happens, the "contribution principle" is being respected in its proper domain, that is, in the Stage II of G^*. As we argued above, it is only in this second stage that the players can meaningfully be said to be making differential contributions to the social product.

By assumption, both the first- and second-stage component games of G^* are cooperative games. Indeed, both the Nash solution and the Shapley Value are cooperative game theories. Moreover, each of these solutions awards the players a utility payoff that is an imputation. An imputation is a payoff vector that is both Pareto optimal and individually rational. (A payoff vector is said to be individually rational if it leaves every player better off than he is to begin with.) Finally, because the payoff from the two-stage game G^* is defined as the payoff from the optimal second-stage game G_{c^*}, we know that the payoff in G^* itself is an imputation. Now given the intuitive meaning of a "contract" as an agreement everyone enters into to improve his situation--i.e., an agreement awarding an imputation--it seems reasonable to assert that G^* is a <u>Contractarian</u> rational choice model. Accordingly, we can summarize our results above with a statement of our

<u>Fundamental Realization Theorem</u>: The ethical concept of full distributive justice can be conceptualized in Contractarian rational choice theoretic terms, and can be realized through a play of a specific two-stage cooperative game G^*.

A formal characterization of G^* and proof of this assertion is found in a companion paper [Brock (1978)]. In that paper Brock has also investigated the problem of political representation. It is shown that there exists an aggregated version of G^*--a game G^{**} played by set of r strategic representatives of the n citizens--which is strategically equivalent to the original game G^* under certain conditions. G^{**} can be viewed as an aggregated Contractarian version of G^*.

Of course, it is not necessary to conceptualize distributive justice in terms of a Contractarian rational choice model. For our earlier discussion makes clear that full distributive justice could as well be realized through an ethical arbitration scheme. Nonetheless, it is significant that a Contractarian model of our theory is available, given the role of Contractarian theories in the history of Western political and moral theory. In this vein, it is interesting to note that the component game G^c (the constitutional choice game proper) of G^* might be viewed as a formal representation of the bargaining game that Rawls originally envisioned when he first introduced his theory of justice in 1957 [see Wolff (1977, Chapters I-V)]. Our stipulation that G^c be a <u>pure</u> bargaining game might in this context correspond to Rawl's requirement that the players be reasonably equal in power and ability.

FOOTNOTES

1. The author wishes to acknowledge the advice and criticism he has received during the development of this theory from Kenneth J. Arrow, John C. Harsanyi, Thomas M. Scanlon, and Lloyd S. Shapley. He is of course responsible for all deficiencies of a technical or conceptual nature.

2. Professor Charles Taylor (1976) expresses the view that these two norms are indeed the fundamental distributive norms. And he cites the inability of existing theories to reconcile these norms as a singular deficiency in moral theory. Additionally, both Nozick (1974) and Wolff (1977) have criticized the Rawlsian and the utilitarian theories for neglecting the question of contribution.

3. The distinction between manna and nonmanna environments was apparently introduced by Robert Nozick (1974, Chapter VII).

4. To introduce the concept of a disagreement payoff or zero point should not be interpreted to prejudge whether or not a suitable welfare function should depend on the zero point. We discuss this matter further on.

5. The only concept that contends with "relative needs" for hegemony here is the concept of impartiality [e.g., Harsanyi (1953)]. We shall discuss the relationship between these two concepts in Section III.B.

6. In the context of a pie division problem where there is a continuously divisible commodity, this case will correspond to an assumption that both players have <u>constant</u> <u>marginal</u> <u>utility</u> for pie.

7. The concept of impartiality as defined here is very similar to the game theoretic axiom of the Expected Independence of Irrelevant Variables used by J. C. Harsanyi (1977a, 154-157) in his axiomatization of the Nash-Zuethen theory.

8. In a future paper, we shall argue that there exists a "proper" zero point that is not morally arbitrary in the context of a theory of justice.

9. Kaneko and Nakamura do not assume interpersonal utility comparisons. They do assume cardinal utility and the existance of a zero point. They postulate

   (i) Invariance of the welfare function under a relabeling of the players and of the social states (Symmetry and Neutrality);

   (ii) Independence of irrelevant alternatives; and

   (iii) Pareto optimality.

   They establish that the only welfare function satisfying (i)-(iii) is the Nash-Harsanyi function which calls for a maximization of the arithmetic product of the players' utility gains. We shall not discuss this interesting result further in the present paper.

10. Harsanyi (1977a, 194) has suggested that the invariance of the Nash theory can be used to establish what he calls an ad hoc interpersonal comparison. Specifically, we are free to rescale the utilities separately such that the game weights a_i, a_j become equal to unity in which case the solution [recall Equation (1) above] assumes the form $(u_i - d_i) = (u_j - d_j)$. This is indeed an ad hoc description since the utilities will not be meaningfully interpersonally calibrated before or after the rescaling. Our own argument is fundamentally different from Harsanyi's. It illuminates how we can interpret the Nash solution if we were to start off with and retain meaningfully interpersonally calibrated scales--something that it is not necessary to do in the context of the Nash-Harsanyi theory.

11. Incidentally, even if we accept Harsanyi's assertion of the need for highly rational behavior (as opposed to highly ethical behavior) on the part of an ethically motivated person acting in the social interest, it is not at all clear why the particular rationality postulates that he should follow are the Bayesian postulates that apply to the special case of individual decision-making under risk and uncertainty.

12. Note that when we speak of rational choice theory, we are in effect referring to single-person decision theory, <u>not</u> to game theory which enters into our theory as has been shown above.

13. Whereas the present paper does provide a thorough account of the concept of allocation according to relative needs, lack of space prevents our giving an equally detailed account of the contribution principle. A detailed treatment of the latter can be found in a companion paper [Brock (1978b)].

14. Auman (1975) has proved the equivalence of the competitive equilibrium of economic theory with the nontransferable utility Value discussed above. He asserts that because of his result, the market allocates utility in accord with relative contribution. However, he does not provide an interpretation of the weights. Hence his conclusions are ambiguous.

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