

Issued Under Office of Naval Research
Contract No. Nonr 1858(16)

PARETO OPTIMUM AND ECONOMIC ORGANIZATION

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Econometric Research Program
Research Memorandum No. 63
January 24, 1964

The research described in this paper was supported partially by the Office of Naval Research and partially by The Carnegie Corporation of New York. Reproduction, translation, publication, use and disposal in whole or in part by or for the United States Government is permitted.

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ABSTRACT

This paper examines some of the hidden, though essential assumptions of the notion of the Pareto Optimum. It shows that there are implicit limitations placed upon the amounts or physical properties of the additions made to the possessions of an individual so that the others, whose position is not to deteriorate, will agree that such is the case. It is shown that bluff may occur and also cooperation among the participants in which case there is no maximum at all but an n-person cooperative game. In that case the objective observer too is involved in a game. Finally it is asked how dynamic aspects could be taken into consideration, pointing up a further complication apparently neglected in the literature.

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by

Oskar Morgenstern

I

If one considers an ensemble of economic individuals, say consumers all, and asserts that when each is in a state of equilibrium all must be better off when nobody's position is deteriorated but one single person's position is improved--according to his own testimony--one seems indeed, to be confronted with an unchallengeable statement. This, then, is perhaps a way to get rid of the unpleasant dilemma of economics which is that on the one hand we cannot compare utilities of different individuals while still staying with the realm of strictly scientific observations involving no value judgements, while on the other hand economists must make assertions about economic welfare. Yet, the time-honored "Pareto optimum", which seems to be the solution and of which the above statement is only one version, has some hidden pitfalls. They shall be opened up and laid bare in the following notes.

The dilemma is, indeed, that we must make statements about social welfare but must also accept the limitations placed upon us by logic. Here the fundamental fact is that welfare statements--no matter what their grammatical disguise--involve "ought"-propositions and that these cannot be derived from factual "is"-propositions. But science can only deal with the latter unless we are explicitly studying a normative science, such as law, which investigates the logical interrelations between norms and determines their compatibility. Economics is descriptive; it turns normative only when advice is given to individuals how to behave in certain circumstances. Welfare economics goes

beyond this limited precept since it wishes to make statements about preferences for different individuals acting not as a unified group unit but as separate entities, having sometimes parallel, sometimes conflicting interests of their own.

Though the derivation of normative propositions from descriptive statements appears quite hopeless there is one type of situation where the transition can legitimately be made. If, for example, a society accepts private property as one of its institutions, it can be shown that the norm: "you shall not steal" follows from the descriptive characteristics of property. Further normative propositions are related to that one so that various de facto institutions can generate a considerable body of norms. Of course, nothing in this analysis of society justifies the conclusion that there ought to be property or not. It is in this latter sense that the dilemma is encountered and remains unsolved. It is this kind of difficulty that a successful inter-personal comparison of utility would resolve.

Whether we are trained economists or untainted by contact with economic science, we do have a feeling that statements about changes in economic welfare are possible and that comparisons of utilities of different persons have to be made. But it is one thing to assert the need and the possibility and another to prove comparability. The latter has not (yet) been done and may never be accomplished in the given framework.

In order to circumvent these difficulties an indirect method has been proposed by Pareto which appears to have found universal acclaim. This is the determination of the "Pareto optimum" for a society. It is defined as that condition of a society in which (a) no reallocation of resources can take place without deteriorating the position of at least one single person,

or correspondingly (b) where an addition to the resources of a single individual may take place so that no other participant will be diminished, thereby increasing the "welfare" of the group as a whole.

This principle makes use of the notion of a simple maximum; i.e., there exists precisely one allocation which is better than any other. This maximum is a set of points, which fact does not obliterate its uniqueness.¹ This maximum is determined by reliance either (a) on the statements to be obtained from the participants or (b) it must be recognizable objectively by an outside observer,--two separate conditions which are not made clear in the literature and whose implications we shall explore in what follows.

An assumption made by the proponents of the Pareto optimum is that the utilities of the members of the group or society are independent of each other. That is, the utility of anyone is supposed to be in no way influenced by the utilities which the others experience which in turn must mean, not influenced by the material possessions of any one else since a person's utilities derive from possession of material things and from services rendered to him.

This assumption is clearly of most doubtful nature. It flies in the face of facts since few things are as obvious as the interdependence of individual utilities. Complementarity, or non-additivity of value, is one of the most prominent features of a single individual's utility structure. The attempt to cope with the difficulties it produces in economic analysis has been hailed as a major step in the right direction. In addition, there is the

1. It is important to realize that the cooperative n-person game solution is of completely different structure. There the alternative distributions or imputations are not even partially ordered. Cf. J. von Neumann and O. Morgenstern: Theory of Games and Economic Behavior (1944, 3rd ed. 1953) p. 34 ff. and passim.

technologically conditioned complementarity among goods which clearly spreads from one individual or firm to the other; but this need not be further considered at present. If it is prima facie obvious that there exists interdependence of utilities of different persons; but if at first it is too difficult to deal with this fact, then it is legitimate to abstract from this condition in order to solve a given problem under these simpler conditions. One has to remain aware, of course, that whatever is said then is subject to grave limitations and that one has to state what they are. The abstraction made would be faulty if it bypasses a fundamental feature of economic reality and if the analysis of the radically simplified situation will never point towards its own modification in such a manner that eventually the true problem can be tackled. (This seems, indeed, to be the case.) Radical simplifications are allowable in science so long as they do not go against the essence of the given problem. Thus it was right for Newton to study the planets only as mass points and to abstract from the fact that there is life on earth. An economist abstracting from individuals as prime movers of the economy would be at fault and could never hope to arrive at a workable theory of economics.

II

We shall show that even when independence of utilities is assumed difficulties arise which are not resolved in the literature.¹

The main issue is that even under conditions of so-called "free competition"--defined as the state where no one's action has any influence on those of the others, where therefore society is made up of a set of independent Robinson Crusoes facing fixed prices and fixed other conditions--the hoped-for general equilibrium may not exist. It is obvious that without equilibrium the Pareto optimum does not exist either, that in fact the one is simply another version of the other. Recently, in a very important paper, Karl Borch has shown² that when uncertainty is introduced explicitly into the Walrasian-Paretian system there can in general be no equilibrium. If this result holds, as I believe it does, some new trick has to be thought of in order to express the idea underlying the Pareto optimum. As Borch shows this would require negotiations among the participants who have to consider uncertainty as a commodity. This market would then have to be viewed as a cooperative n-person game.

It may not be worthwhile to make efforts in the direction of trying to save the classical construct since only further artificial elements would have to be introduced. Uncertainty is one of the basic facts of human existence and must be reflected in economic theory in an absolutely fundamental

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1. It suffices to refer to E. J. Mishan: "A Survey of Welfare Economics," Economic Journal, vol. LXX (1960) and J. Rothenberg: The Measurement of Social Welfare (1961), both with ample references to the literature.
 2. Karl Borch: "Equilibrium in a Reinsurance Market," Econometrica, vol. 30 (1962) pp. 424-444.

manner. To the extent that economic theory is deterministic in character it fails to take care of an essential feature of reality.

The second point is that the condition of "free" or "perfect" competition in the above, classical sense can only be created if an explicit or tacit prohibition is placed upon cooperation by economic individuals. The moment when some cooperation, somewhere in the economic system takes place no simple maximum problem exists. Instead we are confronted with a cooperative n-person game whose solution, i.e. the alternative distributions of proceeds acceptable to the society, has a completely different structure than that envisaged by Walras and Pareto. There exists then no ordinary "optimum", no "maximum". The idea that changes in the position of the whole group of participants can be identified as "better", when the classical operation of improving one participant while leaving the others constant, becomes invalid and inapplicable.

In order to approach this situation it is necessary to add that there is another hidden assumption in the notion of the Pareto optimum. It is, however, an assumption common to all theory. This is the requirement that all participants in the economy are completely informed and able to make all comparisons and computations necessary to determine whether or not they are better or worse off under varying circumstances. This assumption is made (tacitly) by Walras and Pareto and their followers, and (explicitly) by game theory. When it is weakened new problems arise.

If a quantity x_0 of X is given to individual I_0 , in order for him to state that he is "better off", he has to compare his previous possessions with the new addition. This may require for him to make adjustments, e.g., to

dispose of some part of X or of any of his other goods, or to exchange some for others, in such a manner that some prices of the system are disturbed. If big enough, the disturbance will either bring a different general equilibrium or no new one. If the first is the case, some other individuals will be worse off and in the second case a Pareto optimum does not exist by definition. If in a new equilibrium a few are worse off the idea of a Pareto optimum does not apply.

Now in order to determine whether I_0 receives a benefit from x_0 it is not sufficient merely to assume that this will necessarily be so, since due to complementarity and competitive characteristics with goods already in his possession an addition of a new specific good or a further unit may actually be harmful. This possibility appears only to be ruled out if the additions are restricted to money, a restriction, therefore, of the whole notion of the Pareto optimum. But we shall see below that even for money difficulties arise. There is also a difference whether the added good is a final consumer good or an indirect good having no direct utility in the classical sense. (This difference is discussed below.) If one wishes to avoid any restriction of this kind, the individual will have to be questioned for each occasion. If he is not questioned, the burden of proof that he is better off in receiving non-monetary goods falls on the outside observer who then has to make a statement about I_0 's utility, thereby introducing an interpersonal utility comparison between himself and I_0 . This is in violation of the initial exclusion of precisely this contingency. Normally interpersonal utility comparisons are those among economic individuals making up a society. What is pointed out here is an inevitable widening of the notion without which nothing could be said by the outside observer. Strictly speaking even the assertion that any

addition of money to someone's possession is beneficial to him involves an interpersonal utility comparison unless it is based on the individual's own assertion of a benefit. The fact that common sense may tell us that the outsider's conclusion may be justified changes nothing as far as the logical situation is concerned.

If the addition is made in terms of real goods and a question has to be asked of the individual, he may not tell the truth. He may deny the existence of a benefit in order to obtain a still larger one by stating that the benefit to him occurs only when a certain minimum quantity--larger than the one offered--has been reached. While there is no apparent difficulty here, since if he alone is better off (though more than intended) while no others are harmed (but cf. above, p.6 for the possibility to the contrary) other complications arise.

The point is that the other members of the community cannot be indifferent to the changes in the position of I_0 . This lack of indifference is not to be confused with introducing interdependent utilities. It suffices to observe that if I_0 obtains a "large" amount of new goods or money his relative position in the community will change. He will acquire new "power", a fact that is detrimental to others. Power, indeed an important economic phenomenon, can only be acquired at the expense of others, and this is a commodity of a special kind. If the classical formulation of the conditions of the Pareto optimum is expected to include these eventualities, this should be so stated. It is nowhere done, as far as I can see; nor does it seem to be possible to do so. Yet this is a fundamental point. Its inclusion in the assumptions artificially disposes of a problem and its omission brings out into the open phenomena which threaten the underlying idea. (All

this, so far, is without introducing any notions from game theory and its concept of non maximal "standards of behavior".)

This then leads to the need to put a limit to the addition that can be made to I_0 , but how is this limit to be determined on the basis of current views of the Pareto optimum? A recourse to an "infinitesimal" increase is, of course, patently meaningless and offers no way out of the dilemma. Should one nevertheless want to restrict the concept of the Pareto optimum to such cases, the notion would lose all practical and theoretical interest.

It is clear that a dilemma exists: to improve I_0 by giving him one million dollars and leaving all others constant is intuitively seen a very different matter from giving him only one dollar and nothing to the others. Yet as far as the formulation of the Pareto optimum goes there is no difference: in both cases the welfare of the community is supposed to have increased. Since common sense can be a guide in many elementary situations we will conclude that there is at least doubt about the equivalence of the two cases.

The matter goes still deeper: in the ordinary view the Pareto optimum is independent of the fact whether one, two, ... or all individuals get an increase, so long as there is no outright decrease for others (which raises the question of compensations which shall here not be examined). But can those who receive nothing remain indifferent when the number of those receiving additions increases even if the individual increases should not be objectionably large? Common sense again tells us that such will not be the case and there is great plausibility of objections being raised. So there must be a point where an objection appears either for reason of size of addition to a single individual or for smaller additions when the number of recipients becomes "too large".

How are these points determined and communicated? First of all, the additions cannot be kept secret since this would be in contradiction to the assumption of complete information. But this point may not be vital. Second, since it cannot be taken for granted that an addition of anything, except money, in arbitrary quantities is of benefit to an individual he will have to be questioned whether a benefit is obtained. This applies to every participant, even to those who receive nothing but have to be queried because of the possibility of (indirect) deterioration of their relative position.

Now it is clear--always excluding an objective interpersonal utility comparison--that in pursuit of their maximal interest--a basic assumption of the theory--the participants may not tell the truth, and may bluff. The reasons would be to forestall a change to the better in others, in which case there exists a desire to damage another or to exercise a threat. Or, the action follows from genuine fear that relative shifts in "power" may work to their own detriment.

It is only a small step from here--but a step of great consequence--to observe that in order to obtain a larger addition the individual in question may offer a share of this addition to those who plan to object, thereby squelching the opposition. This then is cooperation with side-payments and as such not foreseen by the proponents of the Walras-Pareto line. If positive cooperation is envisaged we are led away from the classical theory to the theory of games. Though a desire to harm others, or at least to prevent them from occupying certain positions is not considered in the Lausanne theory either--yet this is a theory purporting to describe "competition"!--this kind of negative cooperation can hardly be excluded from competitive behavior. The classical theory, of course, cannot cope with it without having its foundations shattered as in the other case.

An interesting and rather subtle point has to be made to demonstrate the complexity of the situation: the members of the group about whose welfare an outside observer is to make a statement are clearly engaged in a cooperative n-person game--probably with side payments--when they interact with each other to obtain a suitable contribution from an outside source. They therefore involve in this game the observer--who need not be identical with the source whence the additional resources flow. They may even form a coalition against the observer in order to extract contributions of certain desired properties. The observer, in his effort to find out whether the group is "better off", may have to question its members but cannot be sure of hearing the truth. This is evidence of existence of this game. The concepts underlying the notion of a Pareto optimum are clearly not suited to take care of these facts. Game theory on the other hand amply discusses the composition of games and the dealings of participants vis-a-vis an outside source.

III

A few comments are desirable to elaborate what was said in II. Why are certain sums of money added to the possession of one individual detrimental to others, and what are some implications of adding non-monetary benefits to an individual?

A certain amount of money added may be of critical importance for I_0 while the same amount may be almost indifferent to others. A certain sum may have vital importance because it may enable a man to have a surgical operation performed on which his life depends. Or our otherwise substantial amount may be meaningless because it does not lead to this effect. This money may allow him to start a new process, a new firm, to create a monopoly, etc. thereby upsetting and spoiling the chances of survival of others. All this will depend on knowledge, on goods already in his possession, etc. It is, of course, possible to get rid of this difficulty by conveniently assuming or defining an equilibrium as existing only when all are equal. But what would this have to do with economics? How could this be in the spirit of Pareto who has elsewhere tried to show a law of inequality of incomes? And how could it be that Pareto himself did not become aware of this inner contradiction?

It is similar with physical goods added, provided they make production cheaper, faster etc. Suppose an electronic computer is given to one while the others have to remain at a lower level of technology? Is that not upsetting and detrimental for some? Suppose neither money nor such physical goods are added to an individual, but instead "only" information, new knowledge.

Can this not completely transform the economy with no assurance that the consequences do not affect negatively some, while benefitting others, thus leading to a situation with which the theory of the Pareto optimum admittedly cannot cope?

These remarks lead on to another part of the problem which should have found attention. Even when there is no overt cooperation among some participants another condition, dynamic changes, may have to be taken into account. We recall the need for the participants to be able to make all necessary comparisons and calculations. This means that they must be capable of estimating consequences of different courses of actions which follow from changes of an individual's possessions. If I_0 receives more money or certain physical goods there must be--at least according to the deterministic classical theory--a unique and "best" way of employing these resources. This he and the other participants would have to predict since otherwise a sensible statement cannot be made whether he himself is better off (and perhaps by how much) and whether the others are not hurt by indirect effects--or perhaps also benefit indirectly.

It is immediately obvious what this requirement entails: the participants must have a very high degree of foresight based on the knowledge of all the data and on a complete understanding of economic interrelationships. In other words, they must possess a complete and correct economic theory¹ (at least covering the area over which the effects of the change reach out).

1. This raises most interesting problems of epistemological nature: what degree of knowledge of which parts of economics is to be assumed to be known to economic individuals when a more comprehensive theory is being established which describes the behavior of precisely these individuals? Obviously molecules do not have to know any physics at all, while it....

In addition it is necessary for them to have a considerable amount of technological knowledge, needed in order to estimate properly the consequences of their decisions upon their own wellbeing and, if possible, also the consequences of the decisions of others. A workable theory is impossible unless this condition is met--or, at least, a satisfactory theory will reveal the indeterminateness with which we are confronted. It should be accounted for in economics, even if the consequences for some theories are as uncomfortable as those described by Borch for the Lausanne theory.

In terms of game theory this much can be said: a participant selects from among his strategies the one (or the combination) which is optimal in the precise sense established by that theory. When an individual obtains new resources, e.g., in the form of additions to his resources as discussed above, this may enable him to form new strategies, perhaps replacing some of the older, perhaps adding new ones. If this is the case and the others cannot do likewise he is necessarily in a better position, the payoffs will be altered, he will have different optimal strategies etc. Whether this change will occur depends on the amount (and kind) of addition made. Game theory is capable of dealing with events of this nature, though this has not yet been worked out in detail as far as I am aware.

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1. (cont.) ... certainly makes a difference whether economic individuals have a knowledge of economics, say of inflation, which then determines a different course of inflation than when this knowledge is lacking. This, in turn, leads to at least two kinds of theories of inflation. Mutatis mutandis the same applies to other areas. Cf. O. Morgenstern: "Logistik und Sozialwissenschaften, Z.f. National-Ökonomie, vol. 7, (1936) pp. 1-24.

IV

The introduction of new products due to inventions is a significant element with regard to more comprehensive statements about welfare--for which the Pareto optimum is only the beginning. But if the notion of the Pareto optimum does not allow extension and application to these wider and more realistic situations it would at best have only very limited interest. Is welfare increased when the motor car or the airplane is introduced? Even if there should be no displacement of existing goods and services (which, of course, does take place) there are indirect effects which must be attributed to cars and planes: there is the disruption of cities, the creation of suburbia, the upset human metabolism due to fast travel in easterly-westerly direction, the pollution of the air, the raising of the earth's temperature due to the discharge into the air of carbon dioxide from new factories, etc.

Somewhere a limit will have to be drawn to which the projection of these effects should be carried in order to assess the influence of change upon the welfare of the community. Nevertheless the extension of the welfare notions over time, under dynamic conditions, seems absolutely necessary. For example, a discount factor for the expected future developments may have to be used but the time preferences of the individuals may differ as much as their incomes. Though we may not be able to do this now--the solution under static conditions still in grave doubt, as shown above--we must at least insist that the static case be formulated in such manner that no contradictions will appear when the expansion of the concept to dynamic cases is attempted. This is impossible within the given framework.

It is odd, indeed, that in the vast literature on welfare economics apparently no attempts have been made to extend the basic idea of the Pareto optimum to more dynamic conditions. On the basis of the above considerations, however, it is clear that an effort towards a rigorous dynamic theory would not succeed.

V

In this section I shall discuss a particular form of new products introduced into a community. In IV we considered goods and services which were like any others already in existence in that they were completely subject to our discretion. We decide where the automobile is to be driven, the airplane is to fly, what to put into the refrigerator etc. But there are now new constructs to whom we delegate decision-making. These are, of course, not decisions as those made by a dial telephone system which determines which circuit is the best to choose from among those available. Rather, they are decisions of an economic kind which either could not be made at all or not in time intervals that are relevant for the planned operations.

In other words these new products are the high-speed digital electronic computers and those devices they are generating in their turn. In particular they are devices which have, or will have, learning capability and the power to adapt themselves to different environments into which they are being placed and which they are shaping themselves in a manner which cannot be foreseen by us before the fact. These new machines make decisions, the old ones merely performed work. The decisions cannot be checked in a suitable time in order for us to find out whether the decision is "acceptable" or not. Acceptability or lack of it can perhaps be established ex post--when the effects of the decision are already with us or past us. Thus, machine activities involve, for example, the setting of inventory levels with the execution of the corresponding purchase orders, production scheduling, etc. But here the consequences are at least recognizable (i.e., the terms in which they occur) though we cannot guess before the event with acceptable confidence

the levels and the other magnitudes involved. These machines or devices commit us and we may not like the nature of the commitment; indeed, we may not like to be committed at all, not for certain areas, or not for the length of time etc.

But there will be other decisions where we cannot now know what they entail. They will set future states of great, impenetrable complexity-- which is precisely why these machines are being used. On these states our welfare depends. Indeed, these machines will design other machines, the nature of which we do not know at present. (This is already beginning in the computer field.)

It is an indispensable requirement for deciding whether the welfare of a community increases that one should be able to describe the consequences of adding a device to the group as a whole or to someone in it. But if, at the time of introduction, it is impossible to do so because the future states cannot be known, then we are confronted with a serious dilemma. Note, that this is not identical with the uncertainty of a statistical nature when only probability limits of an otherwise recognizable state can be given. In that case the notion of mathematical expectation helps over most of the attending difficulties. In this new situation the original decision-maker--the participant who introduces the computer or computer-derivative--may find himself confronted with a behavior of the device which was wholly un-anticipated and to which probability estimates do not apply. In designing it, or in prescribing its operation, he cannot, therefore, lay down in advance all the constraints he would have liked to prescribe because they cannot be seen and formulated until after the experience has been gained. In fact, it may in principle never be possible depending on the ensuing change of environment

and the unchanged ability of the machine to learn how to adapt itself to the new environment which it helps to create.

It is also noteworthy that the introduction of these devices is unavoidable and irrevocable, i.e. they create situations from which we cannot recede any more. Technological change is irreversible at any rate.

It is clear that under these circumstances it is very difficult to apply current notions of "welfare" or to talk even more narrowly of the Pareto optimum. To point up these new phenomena a considerable broadening of our notions of welfare will have to take place. Certain rather obvious concepts, such as "social costs", have, of course, already been proposed but the matter is far more complicated than that. The rather voluminous literature that has arisen in the effort to come to grips with the welfare problem in its strictly scientific aspects is an indication of the interesting difficulties ahead of us.

VI

A brief comment is in order regarding how the idea of a Pareto optimum appears in the light of game theory. Reference has already been made to the limitations of the underlying notion of a "maximum" that pervades all of contemporary economic theory. Game theory on the other hand recognizes that there can be no maximum if the outcome of economic activities depends not only on the actions of the given individual consumer or entrepreneur (plus, perhaps, a chance factor) but also on the acts of others over which the former has no control. This, then, appears to be the normal condition in which an economy has to be viewed. It is, indeed, doubtful that this state can be approached by considering isolated, non-interacting Robinson Crusoes who face fixed conditions on which they never exercise any influence whatever. They represent nothing characteristic of reality, hardly a limiting case (though of some mathematical-formalistic interest). It is therefore doubtful that the legitimate question of welfare can best be approached by remaining within this artificial framework. An orientation of game theory towards this approach will hardly succeed. Rather one should look at the possibility of creating new concepts of welfare which embody the fundamental fact which game theory has brought to the fore, namely that for a society there is no unique "optimum", that, instead, there are "standards of behavior" of vastly more complicated structure to which the simple notion of a unique optimum does not apply. It is therefore perhaps not surprising that to the extent to which the original version of game theory has concerned itself with the welfare problem one was naturally led to the unexpected result that "the

maximum social benefit is always reached".¹ But in order to explain this sweeping statement and to show its rather innocuous content it would be necessary to start from considerations that lead too far afield from the Pareto optimum to which these lines were devoted.

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January 15, 1964

1. Theory of Games and Economic Behavior, Chapter II.