REPRESENTATION OF CHOICE IN LONG-TERM PLANNING*

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1. Introduction

The problem of formulating plans for the long-term development of an economy has received much attention from both economic theorists and practical planners. In order to embody a mechanism of choice in such plans, most theoreticians start with a utility function defined over all feasible growth paths. Little or no motivation is given for the use of such a function. In contrast, those economists more closely linked to a planning process eschew the use of a utility function. For example, Kornai and Ujlaki state: "We do, however, not believe in the existence of such an objective function ["expressing the interests of society in a synthetic manner"] and consider therefore the optimality of each 'optimum' to be only relative." [7, p. 334] The intention of this paper is to discuss issues which must be confronted when using utility functions in planning models. In such a discussion, one must remember that planners will have only limited information and limited techniques available. Thus, this paper does not pretend to be a contribution to the theoretical discussion of social choice but rather a contribution to the literature on planning techniques.

Given that there is some element of choice to be made in a plan, one is forced to confront the problem of who makes the decision and how the decision process is formulated. One school of thought concentrates on the political nature of the decision, and therefore puts analysis of the decision process out of the planners' compass. This view arises most notably in Eastern Europe. Kalecki's analysis is typical. In his analysis of the choice of the rate of growth, Kalecki constructs a 'government decision curve.' "But is it possible to draw the curve in a precise fashion? ... The answer is definitely in the negative. Our curve serves only to illustrate the attitude of the government towards 'sacrificing the present for the future.' Even after the decision has been made we know only [this decision]." [5, p. 35]

However, the government's decisions are intrinsic to the planning process. By emphasizing the political nature of choice, one is merely ignoring the decision process. In so doing, the possibility of analysis of the choice mechanism is precluded. If instead planning is carried out as a constrained maximization process, with the use of a utility function, analysis of the decision making process becomes relevant. New vistas of study may be opened up, and problems which have previously been hidden may be revealed.[1] In an analysis of the use of utility functions in the decision making process, the first question which must be tackled is: from what source will the utility function be derived?

2. The Source of a Planning Utility Function

2.a Social Welfare Functions

A planning utility function could be a representation of a social ordering, where the social ordering itself is derived from a social welfare function. A social welfare function may be defined as "... a process or rule which, for each set of individual orderings $R_1, \ldots, R_n$ for alternative social states (one ordering for each individual), states a corresponding social ordering of alternative social states, R." [1, p. 23] Debate on social welfare functions has centered on the question of whether it is logically possible to construct such functions given 'reasonable' stipulations on the nature of the social ordering and on the form of individual preferences. Little or no attention has been paid to the problems of applying the approach in practical situations.

Impossibility and possibility theorems aside, the main disadvantage of the social welfare function approach must be the impracticality of implementation. One has only to think of the number of social states the planners would have to question voters about, in order to realize the complexity of organization needed to find the social ordering. It is reasonable to presume that, in the foreseeable future, individual preferences will exert an influence on aggregate social choices only in as much as these preferences choose the membership of

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democratic institutions. Thus, although not denying the philosophical attractiveness of the social welfare function approach, one may dismiss it as a helpful guide to embodying choice in present-day plans.

2.b Government Decision Functions

A different approach to the existence of a planning utility function pays more attention to the institutional structure of modern government. In modern democracies, individuals pick representatives who in turn make decisions on behalf of the individuals. Therefore, one may postulate the existence of a central decision making body (for brevity's sake hereafter called government) with which planners interact. The planners' task will be to present to the government a set of plan variants from which the best plan will be chosen.

Before the planning process is initiated it would be unlikely whether either planners or government would know what an optimal path, or objective function would be like. As the planning process continues, both planners and the government will begin to acquire a better knowledge of which plan variants are preferred. One could imagine a formalized procedure; the planners submitting various plan variants to the government and obtaining reactions to those variants in order to obtain better information about the government's priorities. Eventually, the planners could find an approximation to the government's ultimate objectives, even if, initially, the government could not precisely state these objectives.

The process will be analogous to demand theory, where consistency in decision making will imply the existence of an implicit utility function. Suppose that the way in which the decision making body chooses between variants satisfies three assumptions. (Let the relation $A\ R\ B$ mean: plan variant B is not preferred to plan variant A.)

(i) Given a variant A and a variant B, either $A\,R\,B$ or $B\,R\,A$ or both (completeness).

(ii) Given three variants A, B and C, if $A\,R\,B$ and $B\,R\,C$, then $A\,R\,C$ (transitivity).

(iii) Given a sequence of variants, variant $1, \ldots,$ variant $n, \ldots,$ such that their limit exists and is variant Z. Suppose $n\,R\,X$ and $Y\,R\,n$ for all n and some variants X and Y; then $Z\,R\,X$ and $Y\,R\,Z$ (continuity).

Then one can prove that the choices made by the government are such that they could have come from a complete pre-ordering which can be represented by a continuous utility function (see 2). Such a function will be called a government decision function.

Given that the choices to be represented in the government decision function are made in a group decision making process, one can say little on an a priori basis about the likelihood of the conditions being satisfied. Comments usually focus on the continuity condition. This condition excludes certain forms of preferences from the analysis, such as lexicographic preferences. The stringency of the continuity assumption depends upon whether the plan is concerned with a finite number of variables or an infinite number. In the latter case, usually associated with an infinite time horizon, the continuity assumption is much stronger.

Koopmans and Diamond have shown that, under fairly general conditions, the existence of a continuous utility function is incompatible with neutrality towards the timing of consumption benefits when the planning period is of infinite duration. Hence, a government which treats *all* future generations equally will not find its choices satisfying conditions (i) to (iii) above. If the government treats all future generations equally, it may be possible to use a functional representation of choice to find the best plan. Gale has shown that a utility approach can be used to find an optimal plan, even when the utility function is neither continuous nor defines a complete preordering of feasible growth paths. However, the Koopmans-Diamond results do tell us that one cannot use the government decision function as a legitimation for the usage of a utility function in planning when government preferences exhibit neutrality towards the timing of consumption benefits over an infinite time period.

Later, I will argue that both neutrality towards the timing of consumption benefits and concern with an infinite horizon are reasonable requirements for government policy. If one accepts these criteria as a basis for choosing between plan variants, then one must reject the government decision function as the source of the planning utility function.

2.c Selection Functions

The final justification for use of a utility function would be that the government decides to use such an approach to decision making as a matter of choice. Such a justification is not appealing philosophically, as was, say, the social welfare function. Yet, if utility functions are eventually to be introduced into planning, it is likely that pragmatical arguments, rather than philosophical ones, will ac-

company their introduction. Indeed, in both Hungary and France utility functions have been used in planning exercises as tools to obtain numerical solutions to problems. In both cases, there was absolutely no indication that the utility functions used by the planners were ones to be endorsed by government. Use of utility functions in planning simplifies the planning process by allowing the problem to be formulated as a constrained maximization. Apart from this simplification, I will suggest several other advantages of choosing to use a utility function approach.

One problem in evaluating public officials is that one cannot discern their objectives because all one can perceive are their actions which have been constrained by circumstance. If the objectives of public officials are revealed in an open process, then democratic selection has more chance of functioning efficiently in the sense that one would have a greater chance of voting for those officials whose objectives are close to one's own. The explicit formulation of objectives is crucial in a democratic regime where the necessity of recurrent elections imposes a short time horizon on politicians.

Secondly, it is well known that the process of optimization leads to the existence of unique dual prices. These prices would be helpful in the decentralization process which would follow from an aggregate optimization plan. Use of these prices would be important in guiding the economy towards a preferred objective. Only if an explicit choice function were available for use, rather than the government picking a plan variant, would dual prices be generated.

Use of a utility function allows planners flexibility in choosing the number of plans to be published. Without a utility function, planners will have to confer with government on every single plan choice. In a large economy, one single decision process consisting of the planners presenting variants, governments choosing, then planners presenting more refined variants, will be a long and tedious process. The time-consuming nature of the process will not be important when only one plan is to be produced every few years but will be crucial in planning under uncertainty. Consider the case of environmental uncertainty, where the government desires to publish a separate plan for each of many environmental paths. Without a utility function, the government would have to select many best plans from many lists of variants, each list corresponding to one environmental path. In contrast, if a utility function can be agreed upon before planning begins, the planners can calculate a plan for each environmental path without requiring the assistance of the government. Yet still the government's choices will be embodied in every plan. In the same way, replanning, necessitated by the occurrence of unforeseen environmental developments, will be a technical exercise by the planners, rather than a reintroduction of the plan into the political arena. Thus, using a utility function, planning could become a more flexible tool than its present use would suggest.

For the existence of a utility function, representing either a social ordering or a government preference ordering, it is required that the ordering be a complete pre-ordering. Such a requirement might be highly restrictive.[2] For planning purposes, it is required that the utility function differentiate amongst plans in order to define a 'best' plan. 'Best' can be defined in many senses. For example, the overtaking criterion is as strong as the usual definition of an optimal plan.[3] The crucial point involved in redefining the notion of 'best' when the utility function does not define a complete pre-ordering, is that then the only justification for using a utility function is that the government chooses to use one.

With a utility function chosen instead of being derived from individual or government preferences, the thrust of the analysis of the decision making process will be changed. Justification of the usage of a utility function by a social welfare or government decision approach channels research efforts into investigating how individual preferences or government choices may be ascertained, aggregated, and represented by a single function. In contrast, when government chooses to use a utility function, one is entitled to ask: what should be the essential characteristics of a utility function which is to be used for planning? Are there any forms of utility functions which seem more appropriate than others? The ensuing investigation is meant to be suggestive of the arguments which planners would present to a government when the process of building a planning utility function is taking place. In no sense can it be claimed the arguments are the only possible such arguments. In any situation, the correct arguments are the ones which a specific government is willing to support.

The ensuing investigation has a dual purpose. First, when a government chooses to use a utility function, the investigation analyzes the characteristics which one would expect such a function to have. Second, the investigation asks: is it reasonable to rely on the existence of a social welfare function

or government decision function? These functions will not exist if there is neutrality towards the timing of all future consumption benefits. Therefore in focusing on the length of the time horizon and on the rate of time preference, one is also conducting an a priori investigation into the appropriateness of the first or second rationales for the existence of a utility function.

The term 'utility function' is too value laden for the present purpose. This term suggests that the function represents some underlying preferences; the present approach to decision-making does not admit any such interpretation. Therefore, I eschew the term 'utility function' and use the less emotive 'selection function.'

3. The Domain of the Selection Function

Most theoretical models assume that the selection function will have levels of consumption as its arguments. This is natural; consumption is the endpoint of human economic activity. One must define consumption as broadly as possible to include leisure, pollution and all other relevant factors whether goods or 'bads.' I see no reason why any other variables need enter the selection function.

If there is a finite time horizon to the plan then one can define the selection function over a finite number of periods. However, the generations living after the horizon have been forgotten. Any optimal finite horizon plan will decumulate capital in the final years in order to provide higher levels of consumption in those years. Consequently, post-horizon generations will be left with a low potential level of consumption. The welfare of post-horizon generations could be catered for by setting a terminal capital constraint. This constraint will be a surrogate for the welfare of those living after the time-horizon. Therefore, there seems no reason why one should not include the welfare of all generations directly in the selection function. Thus, the justification for an infinite time horizon model seems to be very strong.

It will be useful to delineate three types of consumption goods. First, *public goods*: those goods which cannot be supplied through any known decentralized allocation procedure in a way which would guarantee a Pareto-optimal distribution. The problems inherent in supplying these goods through the political mechanism have been much discussed in the economic literature. Therefore, I will not pursue the matter at this juncture.

Secondly, public goods do not exhaust the sets of goods supplied by the state. The government may supply certain goods through a non-price allocation procedure, even though these goods could be efficiently distributed within the market system. Thus, for these goods, the government sets the ultimate level of demand. These goods are usually called *merit goods.*

Third, a class of goods will be supplied through the market system. Total demand will be the aggregate of individual demands. Government will play no role in influencing or setting the level of demand. These will be called *personal goods.* One must examine how the demands of consumers for personal goods can be incorporated into the selection function. Most planners would emphasize that there must be an attempt to incorporate consumer sovereignty over the set of personal goods.

In contrast to the general agreement on the need for consumer-sovereignty, little attention has been paid to the problem of building preferences into the selection function in a way which is implementable in practice. Let us examine the case of a one-period selection function;

$U(c, d)$, where

$c = (c_1, \ldots, c_n)$ $\quad c_i$ = amount consumed of personal good i

$d = (d_1, \ldots, d_m)$ $\quad d_i$ = amount consumed of public or merit good i.

It is reasonable to ask: how much will planners know about consumer preferences? In terms of present-day econometric techniques, the best one can hope for is probably a set of demand curves: $c = h(p, M)$ where h is a vector-valued function, $p = (p_1, \ldots, p_n)$, p_i = price of ith good, and M = aggregate money income. One can postulate conditions on the demand curves such that the problem of embodying consumer preferences in the selection function is solved. Suppose that demand curves satisfy the following conditions:

(i) $c = h(p, M)$ is defined for any $p \geq 0$ and $M \geq 0$.

(ii) For any positive commodity bundle, c^0, the price vector, p^0, at which the commodity bundle, c^0, is chosen exists, and is determined uniquely up to a scalar multiple.

(iii) $c = h(p, M)$ satisfies $p.\ h(p, M) = M$ for all $p > 0$ and $M > 0$.

(iv) $h(p, M)$ has a bounded derivative with respect to M if $M > 0$.

(v) $c = h(p, M)$ satisfy the strong axiom of revealed preference.

Then the demand curves could have been derived from a preference ordering for which a numerical

representation is possible (see Uzawa). Hence, it is possible to represent the preferences by a synthetic function $w(c)$, say. If one regards the demand functions as approximations to the aggregate revealed preferences of consumers, then the function $w(c)$ can be regarded as an approximation to a numerical representation of an underlying aggregate preference ordering.

If (conditions (i) to (v) were satisfied, then one may write

$$U(c, d) = U^*(w(c), d).$$

The particular choice of U^* will represent the relative weight given to personal goods vis-a-vis public and merit goods. Using U^* in a practical situation will imply that consumer-sovereignty will be embodied in the plan. Call market prices, prices which are market-clearing prices when supply is fixed and demands are generated by individual consumers. In contrast, shadow prices are those prices derived from the plan. It would be found that, for any plan using the function U^* shadow prices would equal those market prices established by fixing supply at the amount suggested by the plan. The identity of shadow prices and market prices is the meaning of consumer-sovereignty. The relative valuations given to goods in the plan (i.e., shadow prices) are the same as the relative valuations given to goods by consumers (i.e., market prices).

The foregoing result is not a panacea for all the problems of embodying consumer-sovereignty in plans. One has no *a priori* reason to believe that aggregate demand curves will satisfy conditions (i) to (v). For example, with the distribution of income changing over time, one would not expect the demand curves to satisfy the strong axiom of revealed preference. However, the result is suggestive of an approach which may be taken. One is incorporating the fact that planners have only limited information about consumer preferences. In so doing, one is cognizant of a major limitation placed on planners in formulating their models.

4. Social Time Preference

In examining the social time preference, one must first consider why it is usually thought appropriate that society should discount future benefits relative to present ones. The justification for such a policy stems from the assumption that most individuals possess a desire for present over future consumption. Thus, a democratic state's policy would reflect these views and exhibit positive time preference. The numerical value of the discount rate would be obtained by voting or from the market place; whichever the government deems appropriate.

The foregoing argument moves the analysis to the level of individual preferences. Why do individuals have positive time preference? Bohm-Bawerk, in his search for a rationalization of a positive rate of interest, was first to systematically discuss the idea. The second of his reasons for a positive interest rate was pure time preference. This was defined as a general irrational underestimate of future wants due to uncertainties, weakness of will, and wrong estimates.

Pigou analyzed the same phenomenon in his *Economics of Welfare*. "Generally speaking, everybody prefers present pleasures or satisfactions of equal magnitude to future pleasures or satisfactions of equal magnitude, even when the latter are perfectly certain to occur. But this preference for present pleasures does not—the idea is self-contradictory—imply that a present pleasure of given magnitude is any greater than a future pleasure of the same magnitude. It implies only that our telescopic faculty is defective, and that we, therefore, see future pleasures, as it were, on a diminished scale." [9, pp. 24–5]

Pigou makes the distinction between desires and satisfactions. Desire is the *ex ante* perception of what the satisfaction will be. Satisfactions are an *ex post* concept; feelings after the consumption has taken place. In the static case, Pigou presumes desires will adequately forecast satisfactions. However, in the dynamic case, because of the defective telescopic faculty, there is a misleading forecast: "... the existence of preference for present over equally certain future pleasures does not imply that any economic dissatisfaction would be suffered if future preferences were substituted at full value for present ones." [9, p. 25] Moreover, the defective telescopic faculty actually harms the person who possesses it: "The practical way in which these discrepancies between desire and satisfaction work themselves out to the injury of economic welfare is by checking the creation of new capital and encouraging people to use up existing capital to such a degree that larger future advantages are sacrificed for smaller present ones." [9, p. 27].

Pigou concluded that the government should try to counteract the low level of individual saving, caused by positive time preference, by biasing its policies towards increasing the rate of saving. Pigou's analysis was carried out for an unplanned

economy, but if the argument is accepted the results would be relevant to a planned economy. Thus, the government should override the time preferences of individuals. Marglin stigmatizes this as the 'Authoritarian' attitude: "Whatever else democratic theory may or may not imply, I consider it axiomatic that a democratic government reflects only the preferences of the individuals who are presently members of the body politic." [8, p. 97] If, as I believe, this statement is normative rather than descriptive, then it represents a rather narrow view of the democratic process. The government's duty is to protect the interests of those who are powerless against a possibly malevolent majority. There is no more clear cut case than the government's duty to protect the interests of the unborn. The link between generations is the state of the country at the passage between generations. Those yet to reach the age of majority, or even to be born, have as much interest in the state of the country as those who are nearer death. The government should not ignore the welfare of present or future citizens solely because they are unable to vote.

The government can take the interest of future generations into account by formulating a rule for growth policy. This rule can be called the rule of inter-temporal equity. It would state that equal amounts of per capita consumption consumed at different points in time would contribute equally as arguments in the selection function. In other words, the social rate of time preference should be zero. Does such a rule, which must be obeyed by the government, violate any form of democratic principle? I think not. Democratic governments are continually subject to rules in their conduct. Some of these rules undoubtedly would not be supported by a majority if put to the test in a vote. The rules are designed to set limits on the degree to which one group can impose its will on another group. In the case of inter-temporal policy, the imposers can be a unanimity of those alive at present, and the imposed upon those who do not yet exist. The government has every right to, and indeed must, take into account the interests of future generations.

To substantiate the case for a zero discount rate, consider a thought experiment in which all generations voted together on discount rates. Remember that, with an infinite time horizon, and a population level which is not falling to zero, there will always be a majority of people yet to live, at any point in time. Let us consider how one person would vote. If the person were to vote selfishly, then that person would vote for a large negative discount rate up to the time of the person's birth, and a large positive discount rate after that day. At any point in time those yet to live are in the majority, therefore the overall vote would be for a high negative discount rate always. Society would value the future more than the present; a result which would be most disagreeable. If the voting confined the domain of choice to a nonnegative discount rate, the majority yet to live would ensure a zero discount rate: equal treatment of all generations.

A positive discount rate is a result of the voting being confined to present generations, for practical reasons. The power of present generations derives from their control of the body politic. There is no justification in democratic theory for these generations to use this power in a selfish manner. Observance of the rule of inter-temporal equity is the way in which present generations will be stopped from using their power in a manner deleterious to the welfare of future generations.

The absence of time preference does not imply a zero rate of interest. There is still Bohm-Bawerk's first reason for the existence of a positive interest rate. This reason is that present goods are valued more highly than future goods because one expects to be richer in the future. In a planned economy, shadow prices will change over time, thus giving a non-zero interest rate. The shadow price of a consumption good is the marginal utility of that good. If one expects consumption to be greater in the future, then shadow prices will fall over time due to the diminishing marginal utility of consumption. If one were to normalize prices so that one numeraire good had a constant normalized price over time, a derived interest rate would be found. In the case of rising physical level of consumption over time, the derived interest rate would be positive.

5. Conclusion

In order to construct a utility function representing preferences derived from a social welfare function or government preferences, one would need those preferences to satisfy the requirements of Debreu's theorem. The utility function constructed would then be continuous. As Koopmans and Diamond have shown, continuity is irreconcilable with neutrality towards the timing of consumption benefits over an infinite horizon. I have argued that both neutrality towards timing of benefits and consideration of an infinite horizon are reasonable requirements for planning an econ-

omy. If one accepts these arguments, then such acceptance is tantamount to rejection of either the social welfare function or the government decision function as justifications for use of a utility function in planning. In these circumstances, the use of a utility function within the plan is purely a matter of choice. I have called this a selection function approach.

Use of a selection function will cause a change in the analysis relevant to planning decision mechanisms. With government decision functions or social welfare functions, theorists must concentrate on finding ways to reveal and combine individual or government preferences. Using selection functions, one would certainly like to take into account individual preferences, but one is also entitled to ask: what characteristics should a reasonable choice function display? Thus, discussion and theorization about the nature of the choice function is a legitimate form of investigation. This is the approach taken in the second half of this paper. The arguments offered are given not as the only possible theoretical arguments but rather as examples of arguments planners would need to formulate in using a selection function for planning purposes.

Notes

1. As an example, non-existence of optimal plans in an infinite horizon model.
2. As Diamond has shown. See the Theorem on p. xx of his article.
3. For a definition of the overtaking criterion see Gale.

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