DIVISION OF THE HUMANITIES AND SOCIAL SCIENCES

CALIFORNIA INSTITUTE OF TECHNOLOGY

PASADENA, CALIFORNIA 91125

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SOCIAL SCIENCE WORKING PAPER 257

April 1979

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It is possible to imagine a boundary between the economy and the environment. Crossing one way, materials are appropriated and extracted from the environment and put to use in the economy. In the course of processing and use, materials recross the boundary as wastes and pollutants. The management of pollution problems and the resolution of issues of depletion and intertemporal equity both occur at this boundary.[1] Economics has by and large confined its attention to the economy side of the boundary, while ecology has focused on the environment side. The role of the boundary and the flows across it, while recognized, has not yet been well-integrated into either discipline, which is not surprising since the boundary area overlaps the two domains. And, although there are increasing efforts to control pollution and rapidly increasing literature on the economics of pollution, the flow of materials across the boundary is, generally speaking, set by the rules of the market, largely unconstrained by considerations of ecology or intertemporal equity.[2] This article considers a policy instrument which operates directly at the boundary -- the ad valorem severance tax.

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A severance tax, which is a tax on material extracted from the environment valued at or near the point of extraction, has the incentive effects of increasing materials conservation, increasing recycling (by raising the price of virgin material relative to scrap material), and increasing product durability. The ad valorem version is essentially an excise tax (or a narrowly based sales tax) and is close to a mirror image of the percentage depletion allowance, which is also based on gross value of a material at or near the "mine mouth." But the depletion allowance is "negative sales tax" representing a subsidy on a materials price instead of a tax on it.

When I began Conservation and Economic Efficiency it occurred to me that a conventional neoclassical economic analysis would prescribe against both the severance tax and the depletion allowance equally, on the grounds that both lead to inefficiency. Yet it seemed to me that there might emerge a useful role for the severance tax if the neoclassical perspective were broadened to include the intertemporal equities involved in the long run use of the resource base. In this chapter I will first sketch three of the ways this might be done and then discuss the role of the severance tax within this broader context. Reexamination of the present value criterion[3] by which the market sets the flow of materials reveals some inadequacies and unresolved issues of the usual interpretations of the criterion and suggests a

rationale, based on equity considerations, for controlling the matter-energy flows across the boundary, while respecting market allocation of the limited flow among alternative uses once within the economy.

THE PRESENT VALUE CRITERION

In resource economics one often finds a criterion of the form:

$$\max_{(c_1,c_2,\ldots)} \sum_{t=1}^{\infty} \delta^{t-1} U(c_t) \qquad (1)$$

such that $(c_1,c_2,\ldots) = c \in E$, where E is the intertemporal opportunity or feasibility set, and where c_t is consumption at time t, or more generally a description of this world at time or generation t, δ the discount factor, and U(·) is a measure of social well-being or utility. For this criterion, the general form of the present value criterion, to have a claim for acceptability, it must rest on some normative base. However, the normative base is rarely discussed, and to make matters more difficult, the units of the variables are typically not defined so that the interpretation of the criterion is ambiguous. There are two obvious interpretations of (1) and several justifications of its general form, none of which seem entirely satisfactory.

In the first interpretation, (1) is a specialized form of the planner's criterion. In other words, we start by writing

the planner's preference function:

$$U = U(c_1,c_2,\ldots,c_t,\ldots);$$

then it is assumed that U happens to be additively separable:

$$U = \sum_{t=1}^{\infty} U^t(c_t)$$

where $U^t(c_t)$ is utility experienced by the planner in contemplating consumption c_t by the future generation t. The planner is assumed to be altruistic toward the future, but not completely so. The planner values consumption in the present more than anticipated consumption in the future by another generation. As a particularly simple way of specifying his declining altruism over time, it is further assumed that

$$U^t(c_t) = \delta^{t-1} U(c_t),$$

which leads directly to (1).

To focus on the intertemporal problem, we assume here and below that each generation acts like a single unit, so that the planner speaks for the whole first generation. Hence, under the first interpretation the units are:

$\delta^{t-1}U(c_t)$ – Utility enjoyed by the present generation in contemplating consumption c_t by generation t.

$U(c_t)$ - Utility that the present generation would enjoy if consumption c_t would be moved back in time to the present generation.

δ - The measure of the present generation's time preference, or in the intergenerational context a measure of the present's altruism (its ability to feel utility from the contemplation of other generations' consumption).

Thus, under the first interpretation (1) is the present generation's utility function. This interpretation is called selfish altruism -- selfish because it is defined as the maximization of the present's utility; altruistic because the present experiences a contribution to its utility by contemplating consumption by other, later generations.

Under the second interpretation, (1) is seen as the criterion of a neutral intertemporal observer, who is trying to be fair to all generations. In contrast, this interpretation is called disinterested fairness, because it results from an outside observer with no direct stake in the outcome, but with the desire to take the interests of all generations into account in some fair manner. The observer knows that if (1) is maximized with a zero discount rate ($\delta = 1$) and if there is productivity in the economy, satisfaction of the criterion with $\delta = 1$ requires that the earlier generations have lower levels of consumption than later generations.[4/]

The observer knows that in a baseline case with productivity -- but no technical change, pollution, resource depletion, or uncertainty -- discounting by the marginal productivity of capital will lead to a maximization of (1) with an intertemporally egalitarian consumption stream. For the second interpretation, motivated by a "baseline egalitarianism," we have

$U(c_t)$ = Utility enjoyed by generation t in consuming c_t.

δ = The marginal productivity of capital.

Under the second interpretation (1) is weighted average of utilities across time with the weights chosen to lead to egalitarian consumption under the baseline case. Of course, a criterion that leads to egalitarian consumption is not very interesting; if this were all that is to the matter, it would be more direct to scrap (1) and state the criterion as simply requiring intertemporally egalitarian consumption. However, the situation offers richer possibilities when the second interpretation is preserved, but the criterion is applied to cases where there is uncertianty, technical change, pollution, and/or depletion.

These two interpretations are conceptually distinct and lead in different directions. The first interpretation has little ethical appeal, if we are to take into account the interests of the future and the possibility that they may conflict with the interests of the present. The second interpretation has some appeal, although it is not clear what is the ethical strength of a criterion

which is motivated by a baseline case and then applied to other, differing cases. Nonetheless, the second interpretation has normative aspects in the sense that it leads to comparisons of intertemporal Pareto improvements. In the interpretation of disinterested fairness the utilities of present and future generations are defined so that it is possible to consider actions which make some generations better off without hurting others. It is possible to consider discount rate calculations in terms of potential Pareto improvements, intergenerationally, as well.[5/] But under the interpretation of selfish altruism, only the first generation's interests or utility is defined so that it is not possible to talk about potential Pareto improvements intergenerationally.

A. Consistency

Consistency is a desirable property as each generation's resource endowment is treated as a sunk cost by that generation, and the present value criterion is consistent, as long as δ is constant.[6/] However, there are other criteria, such as the overtaking principle, which are fundamentally different from the present value criterion but which are also consistent. The overtaking principle says that if, after some point in time, all generations unanimously prefer x to y, then the intertemporal social choice should be x, y. Thus the desirable property of consistency does not single out the present value criterion. Moreover, consistency is a limited property, because it treats the resource endowment passed on from one generation to another

as a sunk cost each time and consequently says nothing about the intertemporal equities involved. As an alternative, the intertemporal choice problem can be viewed in part as what opportunity set to pass on to the next generation. In this case the problem is not to choose an entire sequence of actions or states $(c_1,c_2,\ldots)$ but a pair (c_1,E_2) where E_2 is a "fair heritage" or opportunity set in the succeeding generation and c_1 and E_2 are compatible. In the next generation the task is to choose a compatible (c_2,E_3). As the decision sequences do not overlap, there is no consistency problem in its usual, formal sense, although there may be a need to look further ahead than one generation to specify a "fair" opportunity set for the next generation.

In any case, consistency is probably too narrow a condition. It does not allow, for example, the next generation to have a time preference (δ) different from our own. The desirability of the condition is further blurred by the observation that any criterion is consistent for choosing over the (smaller) set of paths which later planners would not modify.[7/] Thus, consistency is not an all-or-nothing property, but a more-or-less one.

B. Markets

It is sometimes suggested that (1) simply restates what markets tend to do by themselves. Unfortunately it is still unclear just what are the normative properties of sequential market equilibria,

even if there is perfect foresight, when resource inheritance and depletion are endogenous. Most of the work on sequential market equilibria has focused on efficiency aspects. It appears that the simplest thing that can be said is that markets tend to maximize the wealth position of the present generation. From the truism that generally only one thing can be maximized at a time, it is clear that the interests of the future can be in conflict with those of the present. Resolution of this potential conflict is precisely the problem of intertemporal equity. Thus, to say that (1) is desirable as a criterion because it is in some way related to market behavior tells us little or nothing about the equities involved.

C. Paternalism

It is often argued that in an ultimate sense the present must be a dictator, because it is the only generation around to make choices. Thus, necessarily an intertemporal criterion must be an expression only of the present's preferences, including its intentions and altruism toward the future, and its estimates of conditions in the future. As a simple observation as to who is now living and who is yet unborn, this is true, but as we shall see this observation does not lead inexorably to the present value criterion.

THE AGGREGATION PROBLEM

The confining narrowness of the present value criterion can be seen when the choice problem is put in the more general framework of social choice. As before, to focus on the intertemporal problem we assume that each generation acts like a unit (or that the intratemporal problem of aggregation of preferences has been solved). Each generation has its own preference structure over feasible states of the world, where a state is a whole time path from generation one onward. As before, we can write a particular state or path

$$c = (c_1, c_2, \ldots, c_t, \ldots)$$

where c_t is a snapshot of the state at generation t.

If generation i considers path x to be at least as good as path y we write

$$xR_iy.$$

Given that each generation has its own preference structure, and that these preferences are likely to differ because of different vantage points in time among other things, the problem to find some aggregation function F that takes us from the collection of all preference structures, one for each generation, to a single intertemporally social preference ordering:

$$F_i(R_1, R_2, \ldots, R_t, \ldots) \longrightarrow R.$$

With this small amount of notation, we can rewrite (1) in a social choice context. The intertemporal social preference ordering R corresponding to (1) is defined by:

$$xRy \overset{\text{def.}}{\Longleftrightarrow} \sum_{t=1}^{\infty} \delta^{t-1} U(x_t) \geq \sum_{t=1}^{\infty} \delta^{t-1} U(y_t); \qquad (2)$$

and the present value criterion directs us to find a maximal $x \varepsilon E$ under the relation R.

Thus, the present value approach is subsumed under the more general approach of intertemporal social choice, and (2) merely defines one aggregation rule among the infinite possibilities. Moreover, the two approaches are fundamentally different in spirit. Under the discount criterion, the problem is one of maximization. Translated into a market setting, it is necessary to know or estimate future prices and other future conditions. Under the social choice approach the problem is first one of specifying a rule of aggregation (F). As the interest of this paper is on intertemporal equity, the task is to specify a fair rule of aggregation. In doing so, it may actually be a hinderance to know either present or future interests (or preferences). Under a Kantian perspective, one's only hope of describing a fair or just rule is to do so without calculating one's own or other's interests. For this reason the argument of paternalism (C) toward (1) is not forced. Lack of specific knowledge of the future's specific interests does not direct us to (1) with the first interpretation of the discount criterion; indeed, it favors

the more general and abstract approach of looking for fair rules of aggregation.

We can rewrite the interpretation of selfish altruism with the aid of (2) as one particular choice of aggregation:

$$F:(R_1,R_2,\ldots,R_t,\ldots) \longrightarrow R = R_1.$$

This will be recognized as a dictatorship of the present. We can ask under what conditions is this interpretation forced. Since 1972 it has been known that in a setting of an infinite number of voters, the Arrow Impossibility Theorem does not hold.[8] In this setting, which is a natural one for the intertemporal choice problem where we do not want to have to specify the last generation, the Arrowian axioms of Pareto, irrelevant alternatives, and transitivity are consistent with an infinite number of aggregation rules that are non-dictatorial. And quite to the contrary of the dictatorship of the present which is highly present oriented, all the non-dictatorial choice rules consistent with the Arrowian axioms satisfy the overtaking principle, which is highly future oriented, so future oriented that such rules are not appealing as they stand for practical decision making. Nonetheless, this class of non-dictatorial choice rules illustrates an important observation. It is often thought that the alternative to discounting at a positive rate of interest is to discount at a zero rate of interest. The social choice formulation illustrates that there are an infinite number of choice rules beyond these two, narrow alternatives.

Nor is it necessary to view the choice problem as within the context of the Arrowian axioms. As a practical matter we may be willing to give up something in the way of narrowing the set of possible preference orderings, or the set of feasible alternatives, or transitivity, or irrelevant alternatives in order to define rules that are not "too" future oriented, and do not depend on the number of generations being infinite. For example, as a practical matter, we rely heavily, in the intratemporal setting, on majority rule voting, even though we know it can be intransitive. It happens that the overtaking principle, in the intertemporal context with an infinite number of generations, is very much like majority rule, favoring infinite majorities of future generations over finite minorities of generations near the present. Thus as a practical matter we may want to keep some idea of majority rule, in the intertemporal setting, even with a horizon of a finite number of generations. For example, suppose that the next ten generations after us would prefer the resource base kept in some sense intact, but the present generation believes that it is intertemporally "fair" to follow (1) and exploit the resource base in a way that maximizes its present value, but destroys its value for future use providing in its stead many freeways and consumer durables. The most obvious interpretation of the posited situation is that the present has a naive idea of intertemporal fairness, which might change upon deeper reflection. Under the more general framework of social choice, it is likely to seem unfair to choose an aggregation

rule that ignores future interests except as reflected through selfish altruism. A ten-to-one majority is hard to ignore and some form of intertemporal majority voting, with "constitutional" safeguards against the tyranny of the majority, is hard to dismiss altogether.

The approach of intertemporal social choice consists of two parts. First, the effort is to define "fair" conditions or axioms, which will specify a "fair" aggregation rule F. At this stage of consideration a Kantian would find it preferable not to know the actual preferences of the future (or the present either). The search is for certain symmetry properties. Second, after an intertemporal choice rule is defined, such as some modified intertemporal majority rule, one tries to satisfy the rule in actual situations. This requires estimating streams of costs and benefits into the future, just as in the case of (1). It may or may not require a process of maximization. For example, a modified majority rule would not require maximization.[9/]

The Kantian perspective, which insists that just rules can only be defined independently from one's own and others' specific interests, underlies the intertemporal social choice approach sketched above. Moving toward this Kantian perspective is the first way in which the neoclassical approach, taken to be the satisfaction of (1), can be enlarged for a more fundamental discussion of intertemporal equities. This same Kantian base underlies the Rawlsian "original position" with its "veil of ignorance." In both cases, the effort

is to search for ethically attractive conditions of symmetry which will define decision rules that are thereby just. In both cases the future is considered on a symmetrical basis with the present, a condition notably absent in the neoclassical (1).

BASIC GOODS

I sketch here the second way in which the neoclassical perspective can be modified to provide a context for considering severance taxes and other instruments of intertemporal equity. It is convenient to introduce the need for a second change in perspective by considering Rawls' chapter on intergenerational justice.[10] His rule for intertemporal justice is a kind of golden rule of savings: One generation should make an effort of savings equal to what it would have liked the previous generation to have done for it. Capital is viewed in aggregate terms, with natural resources lumped together with finished capital, elevators lumped together with the energy to run them. Rawls is not alone in this view: the assumption that natural resources are just another kind of capital has been a very important one in natural resource economics in the last forty years. In this respect, in his aggregative approach to capital, Rawls appears to be following the neoclassical and utilitarian tradition, which he distinguishes himself from in the rest of his book.

In the neoclassical tradition, the obvious instrument of intertemporal equity is the discount rate. The neoclassical tradition

appears to be saying this: we do not believe that there is a problem of intertemporal equity in the sense of protecting the future, because we believe that the future is going to be better off than the present; however, *if* the present generation decides to (further) improve the lot of the future, it should subsidize the interest rate.[11] This is the most general, and hence the most efficient, way of transferring wealth from the present to the future. But this conclusion depends critically on the assumed homogeneity and aggregability of capital and other economic goods.

Many economic goods contribute to a sense of well-being without being essential to it. For such goods it is a simple matter, conceptually, to define an aggregate value in terms of a compensating variation (or a consumer surplus over compensated demand curves). It is quite possible to imagine, for example, that for an individual there is a certain sum of money for which the individual would be indifferent between having his camera and giving up his camera but gaining the sum instead.

In contrast to such "ordinary" economic goods, others have the property of *sine qua non*. They may trade at the margin but a compensating variation becomes unbounded or indefinable for complete deprivation. For example, suppose the state erroneously imprisons an individual for a few hours, after which time the state realizes its mistake and attempts to make restitution. We can imagine that there could be a sum of money which would be just enough to make the individual indifferent between the state not making the mistake

in the first place and the state making the mistake but also making the compensating restitution. But suppose the state had erroneously imprisoned the individual for forty years. Could we call the individual irrational if he states that he cannot define a compensating sum that would make him indifferent to so much lost life? Similarly, individuals are often willing to work at riskier jobs for additional compensation (risk premiums) in their wages, as long as the increased risk is in some sense marginal, perhaps an extra one out of a thousand chance of accidental death per year. But the risk premium becomes undefinable as the probability of hazard approaches certainty. In the same way it is possible to define a compensating variation, and hence a valuation, to a common cold but not to terminal cancer. For such goods which are essential for a sense of well-being there is no way of defining their aggregate value in terms of compensating variations; and in this way we can distinguish such goods, which can be called basic, from ordinary economic goods.

Basic goods tend to be the building blocks or requisites of other goods. As such they provide opportunities but not guarantees of the good life. In Rawls' inquiry into the nature of justice he focuses on the fair provision of certian basic goods, notably liberty, but also other opportunities. The fair provision, from one generation to the next, of the resource base, characterized in terms of materials, energy, and space per capita (population), can be looked upon in the same light.

Rawls identifies one of the characteristics of the utilitarian tradition as conflation,[12] which appears to mean a tendency toward uncritical aggregation, or "too early" aggregation. His example is the practice of early utilitarians to add utilities across people, as in the ambiguous statement of the greatest good for the greatest number. (Note that the second interpretation of (1) "conflates" utilities across time, but the first interpretation does not, as the only utility is for the planner.) The suggestion here is that the neoclassical tradition conflates ordinary economic goods and basic goods. A more critical view of the assumptions under which ordinary goods and basic goods are aggregated provides a second path toward modification of the neoclassical perspective. It should be no surprise that questions of justice intratemporally often focus on the fair provision of certain basic goods and opportunities, and correspondingly in the intertemporal case of the provision of the resource base, with its implied opportunities.

THE FEASIBILITY SET

Just as the intertemporal state of the world c can be disaggregated into a sequence of generational snapshots $(c_1, c_2, \ldots)$, so too can be the intertemporal feasibility set E be disaggregated into a sequence $(E_1, E_2, \ldots)$, where E_t describes the opportunities open to generation t. The intertemporal feasibility or opportunity set unfolds sequentially and the opportunities available to generation t depend upon the specific actions taken by previous generations.

Previous generations' depletion of materials tends to constrict future opportunities, but the use of materials in constructing capital instruments, along with advances in education and technology may offset, at least in part, this tendency. Neoclassical economists have emphasized the substitutability of resources and the enormous growth in the power of technology, although other determining factors such as population per unit of the resource base, limitations of institutional competence, and conditions of social and economic bahavior have also received some attention.[13]

Further, each generation's opportunity set is bounded by the set of physical laws, which do not change from generation to generation. There are limits to the efficiency which can be designed into an internal combustion engine. Try as we might, the performance of car is not going to increase in an unbounded way, per unit input. For thousands of years with increasing skill and knowledge of the underlying mechanics, boats have been designed to move through the water with less effort, but the bow wave is the same barrier now as it was for the Pharoahs. Indeed, the less understood a physical phenomenon the more scope for technological improvement. A physical phenomenon which is completely understood and exploited in an engineering sense offers no margin for further technological advance. When we are close to understanding, diminishing returns set in to further effort in technical design.

Often a situation is imperfectly understood and it is hard to tell what constraints the laws of physics impose. Yet consideration

of general principles often suggests a bound, though it may not be the lowest bound. A similar problem arises in statistics, where ever more efficient estimators are sought.[14] In many cases, consideration of the information inequality provides a bound to the efficiency, even though this bound may not be the lowest bound and the most efficient estimator under this bound is entirely unspecified.

In recent years more attention in neoclassical economics has been placed on the incorporation of general principles, greatly enriching the realism of the analysis. This represents a third broadening of the neoclassical perspective, which can be seen in the work by Kneese and his collegues incorporating ideas of mass-balance into the analysis of pollution problems, and in the work by Georgescu-Roegen [2] incorporating ideas of thermodynamics in the analysis of the evolution of economic systems.

THE STEADY STATE

One of the neglected questions in the neoclassical tradition is: what is the fair or proper inheritance, with respect to the resource-base, for one generation to pass on to the next? We can go so far as to suggest that this question cannot even be posed in a substantive way under the interpretation selfish altruism. For traditional societies which lived off renewable resources and left the resource base essentially the same from generation to generation, this is not a pressing question.[15] The normative

question of the fair inheritance of the resource base is now more pressing, due to large scale modification of the resource base resulting from our far greater numbers and greater power of technology.

As we become more cautious about aggregation and more willing to keep the difference between ordinary economic goods and basic goods in mind, we become less willing to accept uncritically the discount rate as the obvious instrument of intertemporal equity. Reflection suggests that subsidizing the interest rate can lead to a future with a smaller supply of basic goods (and larger supply of ordinary goods), beyond the level of sustainability. As aggregate investment is stimulated by a general subsidy of interest rates, so too are entropic processes, greater reliance on non-renewable resources, more depletion, and more throughput. Thus it is entirely possible that discount rate subsidy would make the future worse off, providing it, figuratively speaking, with more elevators and less energy.

Greater attention to physical laws of nature, especially in terms of technical substitutability, and entropic processes of depletion and pollution, gives a more realistic description of E, the intertemporal feasibility set. A close attention to physical, energy, and space constraints provides some understanding of the feasibility of sustainable states, at various levels of well-being and numbers of people. Given large scale uncertainties, the normative problem can be restated as determining what is a fair

distribution of risk burden to impose on the future, where part of the risk is that even the present level of well-being cannot be sustained.

The ethical attractiveness of the steady state economy is that it provides an intertemporal world of equals in the basic goods of energy, materials, and space per capita. As such it provides one solution to the aggregation problem posed in the second section. If each generation is treated the same in terms of its basic opportunities, then, this may be fair enough from an intertemporal social choice perspective. A "steady state" is not forever, Georgescu-Roegen points out, but there is a normative difference in choosing a path which leads to severe dislocations in 200 years and another which holds a much greater possibility of tenure for the next 300 million years. It is easy to imagine a Rawlsian original position with representatives from all potential generations choosing a steady state path over a non-sustainable laissez-faire one.

THE SEVERANCE TAX

In a narrow neoclassical perspective it is possible to view the severance tax and the percentage depletion allowance as roughly equivalent distortions (though of opposite sign) of a neutral or intratemporally efficient tax structure. But with the three changes in perspective outlined above the severance tax plays not a similar but an opposite role to the depletion allowance. The

severance tax decreases the tax burden imposed on the future associated with waste generation and depletion and the uncertain search for substitutes by decreasing the rates of material and energy throughput; the depletion allowance increases the rate of depletion, decreases the lead time available for discovery and development of substitutes, and increases the risk burden associated with the uncertain search for substitutes. With the changes in perspective, the severance tax is viewed primarily as an instrument of intertemporal equity, nudging the economy toward a sustainable path. It focuses on the basic goods of energy and materials, which are critical in terms of providing future opportunities. The severance tax is just one among many possible instruments leading toward a sustainable economy, and if a sustainable economy is to be achieved, many or at least several instruments will need to be applied simultaneously. Effective policies toward the stabilization of population are clearly necessary as well, and there should be little doubt that world-wide resource and political problems would be more tractible today if humane policies had been seriously applied fifty years ago.

In Conservation and Economic Efficiency I singled out the severance tax as the illustrative policy instrument of intertemporal equity for two reasons. First, in dealing with the long term management of the material resource base, the severance tax appears to be the simplest pricing instrument which fits into a

"minimally" modified neoclassical perspective. Besides this methodological reason there is a more skeptical and practical reason. As a society we do not deal well with long term, latent problems. We tend to ignore them until they are thrust upon us. As long as there is some easy way to rationalize a laissez-faire approach on the faith that the future will automatically be better off than we, we are likely to procrastinate. At the present moment we stand bemused in the face of massive energy depletion with no really satisfactory substitutes on the horizon; with unsupportable population growth and the dawning recognition that past token efforts have not been enough; with the world economy increasingly based upon pesticides and other synthetic chemicals, some of which the human species itself may not be able to live with for the long term.

In such a world of policy procrastination, discussions of intertemporal equity may arouse a modicum of intellectual interest, but at the same time seem abstract without the imminence to generate significant preventative action. We are in an interim period where energy, resource, and population problems have not landed on us with their full force. There is time to take action but not the urgency to take strong action. Much of what we do now is to provide flexibility and time so that when the blow falls it will be diffused rather than fatal. With this human constraint a useful policy instrument toward sustainability is one which is of little burden to the present but which accumulates its impact over time.

The severance tax has the virtue of low cost to the present with the potential of large leverage for the future. Consider the elimination of present depletion allowances and substitution of national severance taxes of the same percentage (roughly 15 to 20 percent) in their stead, phased in over a five year period. From a neoclassical perspective, which focuses on intratemporal costs (especially under the interpretation of selfish altruism), there is little or no distortionary impact of trading the allowance for the tax, although there are different gainers and losers, intratemporally, and some adjustment costs in the transition. On the other hand, a permanent change in the price of virgin materials of 30 percent or so would have a strong impact on the use and conservation of materials over the long run of fifty years or more. As an added advantage the administrative cost of a national severance tax is no more than the present system, because the administrative apparatus for the depletion allowance can be directly transferred to the severance tax without additional cost, and the cut off points have been precisely defined over the last fifty years.[16/]

It may be noted in passing that marketable quota systems appear to have more political attractiveness when viewed for pollution control. The California Air Resources Board has recently become interested in a marketable quota system to control sulfur pollution in the Los Angeles basin. In this case, the rigidity of the number of quota permits is seen as

a virtue, more nearly guaranteeing a prescribed standard of air quality, than effluent taxes, which are uncertain in resultant air quality and often disparaged as mere "licenses to pollute" (whether the disparagement is just is another matter). Further, preliminary investigation suggests that the most practical way of implementing a quota system on sulfur is to establish the quotas at the level of sulfur content of fossil fuels, including oil to be refined locally into gasoline consumed in the basin and sulfur in gasoline imported into the region, with provision for rebates in quota value for recovered sulfur in the basin, such as an electric utility scrubber or desulfurization of fuel oil. (In the control of pollution, sometimes the gain in administrative feasibility in dealing with the smaller number of firms, closer to the "mine's mouth" outweighs the potential loss of efficiency by not regulating at the point of release to the environment). A quota system on sulfur entering the Los Angeles basin in fuels comes close to a quota system on the extraction of the virgin material.

We can compare the severance tax with its variant, a marketable quota system on the extraction of virgin materials. The principal difference between these two schemes is that the uncertainty associated with the tax is on the quantity of material extracted from the environment, while the uncertainty associated with the quota system is on the market price of the material

extracted. With the quantity of material extracted rigidly fixed, the quota system is a stronger conservationist measure; but unfortunately the quota system involves more short term dislocation and cost to the present. For this reason, in the present interim period, it appears unlikely to be implemented.

The case of the severance tax is somewhat different, however. Because of some of the potential gainers of the tax are in a position to implement it, the severance tax is a rapidly growing tax. The mundane reason for the tax's growing use has little to do with intertemporal equity. It has more to do with the ease in which the tax base can be "exported." For example, in Louisiana where oil and gas severance taxes have recently increased, much of the oil and gas is sold out of state so that people out of state bear much of the burden of the tax. It is little wonder that when Governor Edwards offered to the voters a choice between a property tax increase and an increase in oil and gas severance taxes, they chose the latter. Far from being a drawback of having the tax "accepted for the wrong reasons" the main route of success for long-term policy instruments is to find harmonies between the long term goals and short term interests.

The real mark of success of the severance tax depends on whether or not it is adopted in an internationally coordinated system of trade and economic assistance. It happens that many of the poor countries depend heavily on their resource extraction sector. They are not necessarily resource rich in an absolute

sense, but their economies are relatively weighted toward the resource sector. At the same time, many of the rich countries, which may be resource rich in an absolute sense, are still net resource importers. Since the Second World War the number of buyers has grown relative to the number of sellers, giving rise to concern of unstable markets and a "new mercantilism," replete with efforts for special commodity agreements and the resulting rivalries. Into this picture add the "North-South Confrontation" and the demand for a "new economic order," and there arises the potential role of a system of internationally coordinated severance taxes, based on mutual interests, intratemporally. First of all, developing countries find severance taxes attractive, since they transfer wealth from the buyers to the sellers. Moreover, severance taxes tend to diversify the economies of the poor countries, by making export materials more expensive relative to manufactured and other goods. At first glance it might seem that the buyers, the developed countries, would oppose a system of severance taxes as it involves transfers of wealth from the buyers to the sellers. Upon reflection, however, this might seem a relatively cheap and constructive way of providing economic assistance. The threat of a new mercantilism would be reduced by adjusting the present imbalance between buyers and sellers, and by stimulating domestic production, conservation and recycling of developed countries. Moreover, the North-South confrontation would be ameliorated by this system of assistance, which in the long run would tend to bring the poor

countries out of their trap of raw material export dependence. And finally, a coordinated system of severance taxes may seem better to the developed countries than the present system, with its haphazard emergence of severance taxes and other export controls, including further attempts at cartelization, which are destabilizing even when they fail.

In this mundane discussion of present interests, nothing has been said about the future's interests or intertemporal equity. Discussion of the issues of intertemporal equity provides a new perspective for sustainable economies and a new role for severance taxes and other policy instruments toward this goal. But implementability of such measures depends on finding a harmony between long term goals and short term interests.

FOOTNOTES

1. This is not meant to suggest that all pollution control should be "at the end of the pipe" but that in its essential nature the pollution problem is a boundary problem.

2. Measures to control the costs of pollution focus on charging the form of the flow, not its volume, which is dictated by mass balance and the rates of extraction. Transforming pollutants into less harmful forms is a worthy enterprise, but it is only part of the boundary problem.

3. The present value criterion is a more or less automatic expression of market forces, which lead firms to maximize the discounted, or present value of their anticipated profit streams. Likewise cost-benefit analysis generally dictates the maximization of the present value of the net benefit stream. For an elementary discussion of this criterion see [9, pp. 145-167].

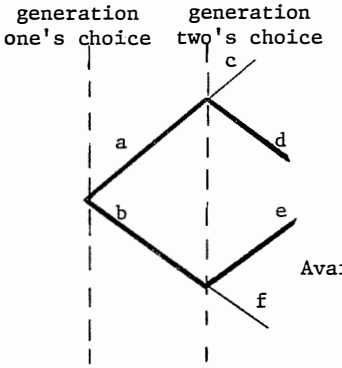
4. Consumption of goods in the present is curtailed in favor of investment, in order to make a larger product in the future, and hence a larger sum of present and future utility. But this process does not impoverish the present without limit if there is diminishing marginal utility, for the future.

5. Elsewhere Mishan and I discuss some of the fundamental difficulties of the principle of potential Pareto improvement applied intergenerationally. The main difficulty is that a potential Pareto improvement becomes infeasible if not incorporated into actual Pareto improvement at the initial period. See [6].

6. For the seminal paper on consistency see the first half of [8]. Consistency is defined in the following way. Under some criterion a planner chooses, in period one, the best plan, which requires certain actions in the first period, and other actions in succeeding periods. During the first period some actions are taken, and then at the beginning of the second period the planner, using the same criterion, but from the new vantage point in time and under the changed conditions brought about by the passage of time and the planners first period actions, chooses a new best plan. If this new plan coincides with the continuation of the old plan, than the criterion is said to be consistant.

7. For example, suppose that this generation has a choice of two alternatives, a and b. If the first generation chooses a, the second generation can choose c or d, or one of the two paths ac or ad. If generation one chooses b, generation two can choose e or f, or one of the two paths be or bf. Generation one would like to plan for both periods, and its ranking of the

two period paths is ac best, then be, ad, and last bf. However, generation two's ranking is ad, ac, be, and last bf. If generation one chooses a, desiring ac, generation two will modify the continuation of the plan to path ad. The smaller set of paths that generation two will not modify is {ad,be}. By construction, choice is consist nt over this smaller set, and generation one is best off by choosing be, which will not later be modified.



Available paths in heavy line.

See [3].

Both the National Academy of Sciences and the Council on Wage and Price Stability recommended an overtaking approach in their analyses of the use of granular activated carbon filtration of carcinogens from drinking water. Construction of filtration

plants would impose costs in the near term, while benefits would be delayed forty years and more due to cancer and mutagen latency. In order to avoid discounting the value of future life over long periods it was recommended that the decision be based on current costs and benefits in the steady state after adjustment of cancer rates to the proposed action. In other words, the indefinitely long future should prevail over the transitory present, for this decision involving basic health. See [1], [5], and [10].

10. Chapter 44 of A Theory of Justice [11].

11. It is usually left unspecified how the interest rate could, or should, be adjusted. Business income taxes, dividend taxes, and changes in the supply of money affect interest rates, but these and other instruments also affect the rate of inflation, unemployment, and the tax base as well. Because the interest rate has several important macroeconomic effects, it is unclear how it could or should be used for the purpose of intertemporal equity, and how the various effects should be traded off. In contrast, the severance tax has smaller and more localized "side effects." Krutilla traces back to Pigou the first suggestion to use the interest rate adjustment for controlling the use of natural resources, by the government as "trustee for unborn generations." Besides suggesting the device of guaranteed

interest, Pigou mentions taxes and State loans as other possibilities. (conversation with Krutilla, see more generally [ ].)

[11], p. 27.

For example, it is recognized that the difficulty of resolving simultaneous inflation and unemployment constitutes a real constraint on the opportunities available to society as a whole; and moreover that simultaneous inflation and unemployment in part results from economic behavioral conditions of price and wage expectations.

See [4A] for a definition of the information inequality.

Such societies are a prototype of the steady state or spaceship earth economy described by Boulding and Daly, but at a lower level of material well-being, and one of the present empirical questions is at how high a level of material well-being can a modern version of the steady state economy be achieved.

A cut off point at which the market value of the material is the stage of processing -- nine month, benefication, etc. -- is taken as a base for the depletion allowance or for the severance tax.

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