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Economic Resources and Cost Benefits Analysis within the Environmental Context

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1- Introduction:-

The nature of marginal opportunity cost

Marginal opportunity cost (Mou Demonstrates the true cost of consuming an extra unit of a resource. As such, it must take into consideration the direct costs of using the resource. The user cost of the resource (depriving future users) and the external cost (effects on other sectors). Formally,

MOCI=MCI+MUCI+MECIJ

where

MOCI=Marginal opportunity cost of the ith resource
MCI=(Direct) marginal cost of extracting the ith resource
MUCI=Marginal user cost of ith resource
MECIJ=Marginal external cost of using the i-resource on the j-sector.

It should be stressed now that the MECIJ elements is important, since the use of most natural resources causes, through the delicate system of ecological interdependence, changes in other sectors. An example might be that of a building project which uses land, but also creates excessive water run-off so that river sedimentation rises and water stocks are affected. MEC should also include some "Disaster element" which considers the effect that depletion of natural resources has on the environments capacity to regenerate after a shock.

MOC may be used simply to discuss the difference between renewable and non-renewable resources. In summary, an exhaustible resource is likely to have a higher MOC than a renewable resource. This for a number of reasons. Firstly, the marginal costs of extracting a non renewable resource, if low in the present, will increase over time, as deposits in less accessible places become viable (Metenberg 1992). The marginal user cost of a non renewable resource is implictly higher than that of a renewable resource since its consumption deprives any future would be user, whereas if the resource is renewable, this is not the case. The marginal external cost of non-renewable resources is also likely to be higher than that of renewable resources, since any effects of depletion will be permanent giving rise to a stream of future costs. In the case of renewable resources, the MEC will fall again after regenration.

However, the renewable nature of resources is not fool proof, if subjected to over exploitation their regenerative capacity will fall, increasing their MOC. A rising MOC could therefore be taken as an indication of over-exploitation of renewable resources up to a point, the losses incurred from over-use are reversible, and through sound management MOC can be reduced, but there is a point beyond which over use transforms renewable resources into non-renewable resources with a permanently high MOC.

Given that depletion of exhaustible resources and over-use of renewable resources necessarily implies a "Run-out" date, we could include the cost of research into, and implementation of backstop technology in the MOC equation. By "Backstop technology" we mean "Technical" substitutes for natural resources, for example use of LPG to provide the evergy formerly provided by fuel wood. Economics assumes that individuals utility maximize, if they intend to increase utility in the long run. Maintaining consumption levels which involve resource depletion, investment in backstop technology would constitute utility maximizing behaviour. It should be recognized though, that the possibility of backstop technology is not universally applicable. In some instances it is simply infeasible, in other instances it may be technically possible but have such a high discounted marginal cost as to be inviable.

2) Marginal opportunity cost in the cost benefit context

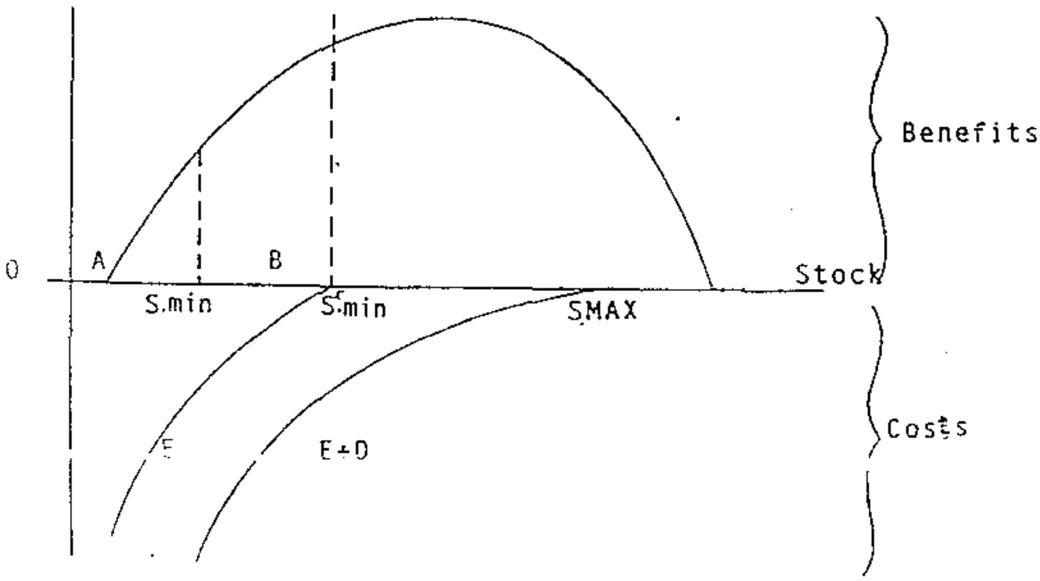
Since cost benefit analysis (CBA) is the most widely used procedure for project evaluation it is important to adapt MOC to fit it. The general condition for project approach is

Bi - Ci > 0

Where Bi=Benefits from project i

Ci=Costs of project i

It is possible to portray this diagrammatically, by commuting verhulst's logistical growth equation to represent the benefit function (Clarke 1990).



Smin=Minimum critical stock size (below which damage is irreversible)

S*min=Stock level consistent with sustained use of the resource over a long period.

S*Min>SMin

E=External cost function

E+D=External cost+direct cost (costs of extraction fall due to economics of sale).

Any point, such as "A" to the left of S min represents extreme and irreversible resource depletion. Any point between S min and S*min, such as "B", represents short-term over-use which will cause irreversible damage if prolonged. Clearly the aim of policy must be to shift to a use-pattern correspondant with stock levels>s*min, and even when this is not possible, to move to a use pattern with greater stock levels in countries fortunate enough to be at a situation where S>S*

Thinking in these terms may prevent them from entering into use patterns destined to reduce stocks below S*min, although we must recognize that development pressure, which may lead to natural resource degradation are high.

MOC is clearly important, since it is when MOC is incorporated into the cost-benefit framework. That environmental factors are given credence MOC acts as a true measure of resource scarcity and is therefore superior to traditional indicators (Eg. supply demand balances). MOC also considers intersectoral effects, which are ignored in traditional CBA theory. It is quite possible that projects with conventional rates of return below the discount rate will seem viable when externalities are considered. In fact, given the extensive intersectoral linkages within the environment, it is possible that the whole single-project evaluation framework is outdated, and that a more integrated approach is required.

Unfortunately, the standard accounting and even shadow pricing structures do not value total environmental cost as well as MOC. They generally take their "Set Price" as the border price (c.i.f. including costs of transport to market for imports, f.o.b. for exports), and this certainly does not reflect domestic externalities.

Even MOC, though, is not necessarily a perfect indicator of true social cost. The "Opportunity cost" refered to in MOC is the opportunity cost of a particular activity and its effect, not of using the intrinsic value of the resource. In M.O.C., then, the source of the resource has no effect. Yet in reality, this clearly is not the case. Fuelwood provides a good example. Demand is high in both rural and urban areas, yet the cost of using a replacement such as LPG, is less in the urban areas, due to technology and transport costs. If we calculate user cost to include an element for backstop technology, user cost is clearly higher for rural populations than for urban populations. It is therefore the "Backstop Inclusive" interpretation of MOC which is more useful.

3) A Model for M.O.C. :

M.O.C. is not intended only to measure present costs but also to measure future costs incurred by future users in order to do this a measure of the safe minimum standard (S*Min) must be achieved since the MOC will depend on whether present stocks are above or below S*min.

Evaluating S*Min is, in itself, an exhausting task since any safe minimum standard will depend on many diverse factors, present and estimated future. In the case of agricultural fertility, s*min will depend on present and future estimates of water and air quality. Technology quality of labour and so on. The necessity of using future estimates adds even greater uncertainity to the process and it is necessary to calculate s* for both best-and worst-case scenarios. So even then, s*Min is more likely to be a range of values than a single quantity. Population too, changes over time and so s* will vary over time also-another element of uncertainity.

Earlier we distinguished between the situation where stock levels are above or equal to s*min and the situation where stock levels are below s*min. Each situation provides different policy alternatives.

If the stock level is very far below s*min so that there is no hope of restoring the ecosystem, the only option is to relocate the population and start over. There is no way to survive in a completely disrupted ecosystem, and if the population is relocated it must be hoped that they would learn from experience. If this is the situation we face the user costs of further depletion should be measured in terms of the increased present value of moving and resettling the population sooner than would normally be the case.

If however, the ecosystem, although depleted below s*Min is not beyond redemption there is another policy alternative in order to restore an ecological equlibrium the marginal user cost should include the additional present value of the costs of re-creating the system. These costs may include fees for replenishment of wildlife stocks, re-forestation, cleaning of water supplies, soil revitalization etc. In order to calculate the marginal costs of these actions, consideration should also be given to the increased depletion of resources which will still be taking place due to the population remaining in the area.

Diagrammatically this could be represented in terms of Figure 2, by following path A instead of path B.

Resource Stock

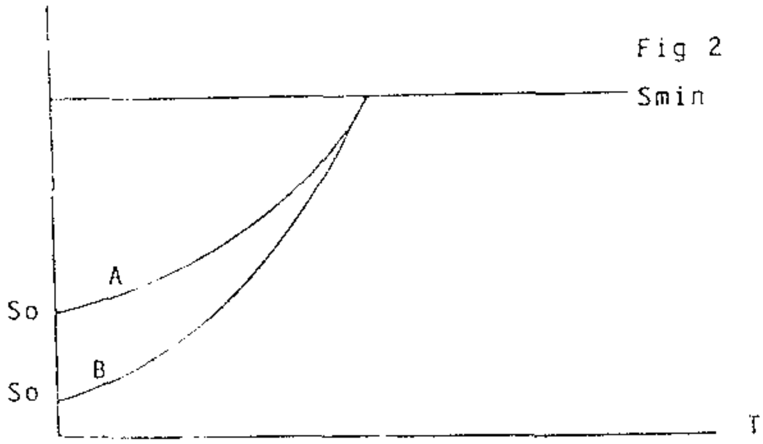


Fig 2

There is, of course, a specific time horizon within which s*Min must be achieved. If this is breeched the project should be abandoned. This time horizon will be generated by administrative, practical and technological considerations.

If the current stock levels are above s*min then we are fortunate, since prevention is better than cure. Depletion policies should be calculated so that stocks can be maintained above s*min. As soon as stock levels reach s*min we assume that a backstop technology is used. For renewable resources this is consistent with the criterion for sustainable development (pearce et al 1990) the rate of depletion until s*min is determined by the demand for the renewable resource, which depends upon the private marginal costs of collection plus distribution, rate of population growth, changes in tastes and preferences, regeneration rates and the price elasticity of demand for the resource, which are exogenous to the model since the policy actions which may influence them are not determined here.

The government should not intervence in the rate of depletion until either marginal social costs of collection plus usage are greater than cost of introducing back stop technology, or when the stock has fallen to s*min, in both these cases M.O.C.=Marginal private cost of collection +

distribution + Marginal external costs of depletion + net present value of unit of resource at TM (where MEC includes an element for "Disaster Cost").

The element for "Net Present Value of a unit of resource at Tm' will be equal to the difference between the price of the backstop technology at Tm minus the marginal social cost of the renewable resources, discounted to the present and with any growth the renewable resource would have achieved, considered.

It should also be noted that a policy dedicated to preserving s*Min is not likely to be the optimal policy. It is however likely to be more realistic, taking into account a general tendency to "Crists Government" in environmental matters.

It should also be noted if a Government notices its stocks approaching s*min then it is possible that they may decide to adopt a conservation programme before Tm is reached. This time-horizon is therefore not absolute. The conservation programme may involve direct policing of stocks, and encouragement of higher regeneration rates, or an attempt to reduce demand by effective taxation.

Formally

n=Growth rate of population of a region

v=Regeneration rate of renewable resource

$\lambda 1$ = Growth rate of real MC of backstop technology

$\lambda 2$ = Growth rate of real marginal environmental cost of extraction plus use

$\lambda 3$ = Growth rate of real marginal environmental cost of use

η = Price elasticity of demand for renewable resource

s = Social rate of discount

d_1 = Minimum acceptable stock of the resource as a proportion of the initial stock

d_2 = Initial direct marginal cost of the resource as a proportion of the initial marginal cost of the backstop technology

d_3 = Initial marginal environmental cost of using the resource as a proportion of the initial marginal cost of using the backstop technology

d_4 = Initial rate of consumption of the resource as a proportion of the initial stock (s)

C_B = Initial marginal cost of the backstop technology

Assumptions: $d<1$ and $(d+d)<1$. This implies that the marginal social cost of the resource is less than that of the backstop technology, and that the existing stocks are greater that the minimum acceptable level.

The single most important element of MUC, and therefore MOC is v, the regeneration rate, since if this is high enough s*min need never be reached and a great deal of economic and environmental effort would be saved.

In order to preserve the regeneration rate an amount of stock which will maintain regenerative capacity should be protected. It is this idea which provides the essence of the findings of the Brudtland commision.

4) MOC and the discount rate :

In the model outlined the marginal user cost is an important element in M.O.C. In calculating the M.U.C. it is necessary to derive some value for the "Social Discount Rate(s)". It is no longer adequate to use a traditional financial discount rate (such as the rate of interest of Keynes Marginal Efficiency of Capital) since the project under consideration will also have wider, social effects which must be.

Considered arriving at a figure for the social discount rate therefore implies assigning some relative value to these present and future social consequences.

Turner (1993) lists six possibilities: Firstly where value is assigned to future welfare, although current welfare is more important ($0<\text{Discount rate}<\alpha$); where future welfare is almost as important as present welfare ($o<s<\text{Discount rate}$); where discounting may take place only after environmental protection strategies have been implemented. Where future welfare is assigned more value than the present ($s<o$);

where future welfare is given the same value as present welfare (s=o); and lastly where future values are not considered at all important (s= α).

The value assigned to the effects of a project on society in the future will depend upon the reliefs of the individual making the assessment, and their particular situation.

Firstly, if the individual, or indeed nation is suffering adverse conditions in the present, he is more likely to assign less importance to future effects, whatever he expects them to be. This is certainly the case with many less developed countries many of which are simply unable to afford to consider future effects. So bad is their current situation, thus their social discount rates are high.

Secondly, those who subscribe to theories of weak sustainable development will have higher social discount rates than those who believe the ideas of strong sustainable development again Turner (1993) usefully classifies the sustainable development philosophies into 4 types.

The very weak sustainability approach merely seeks to maintain the total level of the earth's capital stocks over time. Formally: It should be

Km+Kn+Kh=C

Where

Km=Man-made capital

kn=Natural capital

kh=Human capital

C=A constant

Thus a project which has socially damaging consequences in the future (eg. Degradation of natural capital stock) may still be viable as long as improvements may be made to another form of capital to offset this. People who subscribe to this theory assume perfect substitutability between the different forms of capital, and will have a relatively high social discount rate.

The weak sustainability approach recognizes that the different forms of capital are not perfect substitutes. Pearce and Turner (1991) add to this the idea of a minimum stock of natural capital and also the recognition that the assimilative capacity of natural capital is limited. This thinking adds a "sustainability constraint" to economic growth, if the constraint begins to bite, or if it is thought that the constraint will begin to bite. Social discount rates will fall, since damage to natural capital stocks in the future is considered to be of value.

The strong sustainability approach goes a step further, advocating that natural capital stocks must remain constraint, whatever benefits are foregone to achieve this. Future effects, are therefore valued equally as present effects, and the social discount rate would be zero.

The very strong sustainable development approach, puts forward the notion that scale of economic activity on earth has already surpassed a "safety limit" and that any further growth would be to risk environmental catastrophe, any ideas of development should be fulfilled by augmenting "Moral Capital". Even renewable resources are forbidden since their use will create social externalities. In this approach as in strong sustainability, future present effects would be weighted equally so that the social discount rate would be zero.

The type of sustainable development advocated in Brundtland would be most effectively defined as "Weak" and if such a position were to be widely adopted social discount rates would fall. From the M.U.C. formula we can see that a fall in social discount rates would increase MUC and so increase MOC. Making fewer projects viable in a cost benefit framework.

It should be noted here that problems still exist with this approach. The problem of assessing future outcomes is still very much a consideration. In many cases calculating a practical social discount rate would involve making educated guesses about the future consequences of a project, and there is debate about whether or not to include a margin of error in the calculations (Pearce et al 1990).

Having carefully discussed the methods through which a social discount rate might be "improved" to take more account of intergenerational equity, it would restore a sense of perspective to remind the reader that the necessity of this excercise is questionable. Sen has argued that discount rates already make allowance for intergenerational effects, through "overlapping utility functions" this means that although the discount rate takes into account my utility functioned, my utility depends in part on the utility of my children and my grand children, so that....

s= (Vi) Vi= (Li,Vj, Vk)

where

s = Social discount rate

u = utility, c=consumption

i = current generation

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$$s = \delta (vi) \qquad vi = \delta (Li, Vj, Vk)$$

where

s=social discount rate

u=utility, c=consumption

i=current generation

j=next generation

k=third generation (pearce et al 1990)

If this argument is true then the imposition of any premium for intergenerational effects would reduce the discount rate by too much. Creating a sub-optimal rate, this would carry on through our M.O.C. model to produce a sub-optimal allocation of resources which may even damage the environment further.

5- Conclusion :

The true economic cost of natural resource depletion may be measured by marginal opportunity cost. MOC includes elements for marginal cost of extraction, marginal user cost and marginal external cost. Since marginal user cost is a measure of lost future use of the resource its formula should include some measure of the social discount rate. While some people believe that traditional discount rates are adequate, others are of the opinion that they should be improved for intergenerational effects.

Once a value for MOC has been achieved, traditional cost-benefit analysis provides an adequate framework for viability studies.

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