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THE NECESSITY OF SPECIAL DISCOUNTING TREATMENT FOR NATURE TO ASSESS THE FLOW OF INVESTMENTS

ABSTRACT

The purpose of the paper is to justify special *natural* discount rates in the efficiency assessment of conservation activities. Nowadays, the ***social rate of discounting*** suggested by D. Pearce is often used. However, many ecosystem values differ in such aspects as absence of high-grade anthropogenic substitutes and conservative character of natural "technologies", and consequently simple, not expanded, reproduction. As a result, there exists the need for special discounting rate for non-replaceable production and services restricted in their reprocessing and consumption. This follows from the analysis of a consumer choice trajectory in the course of budget growth over a level at which the maximum of consumption of the limited good is reached. The paper estimates the reduction value for discounting rates for renewable natural resources restricted in regeneration in the special case of individual utility functions of the Cobb-Douglas type and, for a collective consumption, using equal-parts resource sharing among consuming community members. The idea of special discount rates for the production and non-material services of ecosystems is useful both for economic efficiency assessment of nature conservation activities and for calculation of compensations from the activities that adversely affect environment quality.

KEY WORDS: discounting, natural discount rate, investments, ecosystem production, ecosystem services, effective strength of environmental activity

INTRODUCTION

There is often a need to evaluate future or past projects from aprioristic or posterioristic points of view in comparison with baseline scenarios that assume absence of such project activities. Some of typical situation are presented below.

1. ***Nature in the Future (NF).*** For example, it may be necessary to compare some scenarios of national park organization or of realization of tree-planting works. It is implied that any of these scenarios increases the value received from functioning of conserved, improved, restored, or established ecosystems, but probably leads to losses from the missed opportunities of alternative use of the occupied lands or of the resources located on them.

2. ***Economic activities in the Future (EF).*** A private or public investment project, which may lead to reduction in a stream of products and services of destroyed or modified ecosystems or to deterioration of environment characteristics, has to be evaluated. It is required to estimate practicability of the project from a complex ecological economics point of view: whether planned new values of anthropogenic origin will outweigh ecological losses.

Both of described variants *NF* and *EF* plainly demand for putting to the current time the estimations of various scenarios of planned conditions of natural stocks and streams of ecosystem products and services. Thus, a hectare of a forest today and a hectare of the same forest to be planted in 70 years have apparently different current, normalized to today's perception, value. So, here arises the problem of correct discounting.

Let us consider two other situations.

3. ***Nature in the Past (NP)***. This situation arises when nature protection or environmental engineering actions have been carried out, which has led to increase of steady streams of resources and services of ecosystem origin useful for human beings or to the occurrence of a predictable trend in increase of stocks of such resources in comparison with a baseline scenario that assumes absence of such measures.

4. ***Economic activities in the Past (EP)***. This situation is associated with realization of an investment project or with economic activities that resulted in outcomes (often unforeseen) that have led to decrease in stocks of resources or steady streams of products and services of ecosystem origin or to occurrence of a predicted trend of such resources or flows reduction. In this case, it may be necessary to estimate sizes of indemnifications from initiators of such changes.

Situations *NP* and *EP* also need selection of the rate of discounting for the goods of ecosystem origin (or of a set of various rates for the natural goods of different types) which are affected by the activity of these two mentioned types. (It is important to notice that when actions of types *NP* or *EP* lead to a simple lump-sum change of material stocks of ecosystem origin, the problem of the correct discounting does not rise.)

THEORETICAL ANALYSIS OF THE PROBLEM: STARTING POSITIONS

This paper is not concerned with the tendency of the rate of social discounting to change (namely – to abate) with increase in horizon of planning or may be simply with a course of normal economic development. Pearce et al. [2003] and Groom et al. [2005] provide a good review of such research approaches.

The goal of our paper is to demonstrate that discounting of non-replaceable products and services of ecosystem origin is different from that of socially consumed goods of anthropogenic origin. In addition, we tried to estimate discounting comparators in some typical situations.

This material may seem as incomplete or debatable. However, we hope that it will highlight a number of specific features of ecosystem goods which have been lacking attention in the past. This paper also attempts to identify possible steps to develop further approaches to discounting.

At the present time, the term most often used is the so-called social rate of discounting suggested originally by D. Pearce. This approach considers that goods of ecosystem origin have the same social importance as, for example, free parking for personal motor transport. It is assumed that the rate of social discounting reflects pure intertemporal preferences of a society which is different from the commercial rates that reflect possible speed of the capital gain at its alternative investment.

However, unlike paved parking, many of ecosystem goods differ in such aspects as, *first*, in the absence of full-value substitutes of anthropogenic origin, *second*, in conservative character of natural "technologies" and, *third*, as a consequence, in mechanisms for reproduction of these goods (simple vs. expanded, for anthropogenic goods).

For any of the types of assessments mentioned in the Introduction, setting a *low and the same for all goods* of natural and anthropogenic origin discounting rate (though possibly changing from year to year) will inevitably lead to losses in the near planning horizon.

First, it is reasonable to assume that for conventional replaceable goods that can be produced on sustainable basis, one will, most likely, prefer to have some of their quantity today rather than in some uncertain future.

Second, when the rate of discounting is made compulsorily low without the distinction concerning the type of discounted goods, the opportunity of reinvestment of financial assets, which can be received from the projects with fast feedback, is underestimated.

NEED TO DECREASE THE RATE OF DISCOUNTING FOR THE GOODS LIMITED IN CAPABILITY OF REPRODUCTION

Let us consider a typical, a well-known from many basic level textbooks on economics, situation of the individual choice between consumption and non-consumption (and spending the remaining part of expense budget for other goods) of some fixed good presented on Fig. 1.

In this figure, each curve sets some fixed level of total satisfaction from simultaneous consumption of all goods. Therewith, one *fixed* good is opposed to all other goods consumed by an individual, and their consumption is *measured* by the sum of money spent on them. Any of the points at any fixed curve on the diagram are of equal preference for the individual, and a real choice is determined by aspiration of expenses minimization. We consider that money acts as a uniform measuring instrument for expenses of various sorts. Expenses can be financial, temporal, physical, "moral", and possibly other. The individual has to choose between consumption of some chosen product and consumption of other goods over any time interval, for example, over a month. For simplification, it may be assumed that the total expenses to maintain consumption of an individual product are directly proportional to the quantity of consumed units and that consumption of other goods is measured directly by their money's worth. Descending inclined straight lines display budgetary restrictions at various levels of a consumption budget. The osculation points of these straight lines to the curves of maximally accessible utility level represent real consumer selections at various levels of the budget. The consumer choice trajectory is presented on our diagram by an ascending inclined straight line (generally the trajectory of a choice can be a line of more complex configuration) connecting these points. The slope of the indifference curve in its arbitrary point characterizes the

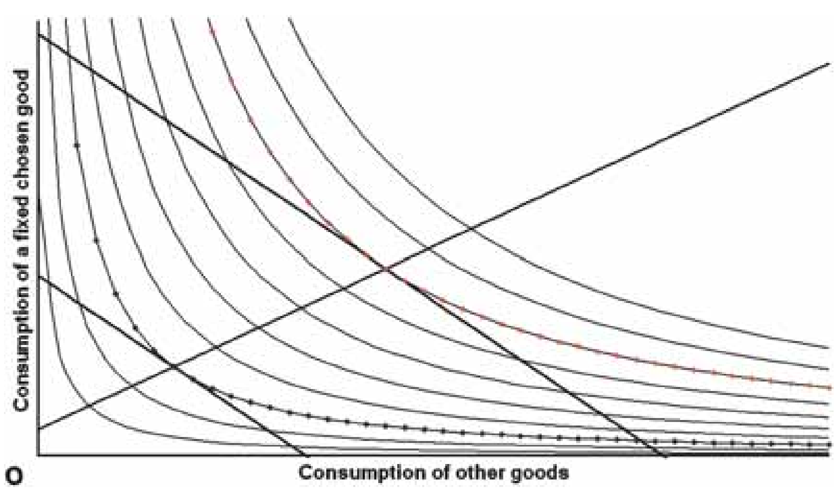

Fig. 1: The indifference curves graph, budgetary restrictions, and a consumer choice trajectory associated with consumption of the fixed chosen good in comparison with expenses on consumption of others goods

value of an additional unit of the fixed good. Specifically, the steeper the backslope of a curve, the more valuable to the individual is consumption of an additional unit of other goods in comparison with consumption of a unit of the fixed chosen good. The backslope of an indifference curve shows a marginal relative value of the good represented on the horizontal axis.

Let us assume now, that the fixed chosen good is trips to nature with restricted maximal number of trips per month (for example, by a number of days in a month [for a person with a flexible schedule] or by a number of weekends [when only they are available for travel]). The consumer choice trajectory is now transformed approaching the shape presented on Fig. 2.

Until the consumer budget reaches a critical value at which the individual chooses distribution of expenditures that maximizes the general utility and achieves the greatest possible consumption of the restricted good, the point of the consumer choice moves along the segment OA_{crit} of the choice trajectory. Therewith, in a point of choice, the relative value of the consumed goods is determined by the parity of the expenses associated with consumption of a chosen good and all other goods. In theory, i.e., in the absence of time, "moral", and other transactional costs, it is determined by the price of the limited good expressed in monetary units. Further, when the budget critical level is exceeded, the consumer choice trajectory is forced to follow the horizontal half-line $A_{crit.}A_{+}$, and in a choice point, the marginal relative value of the restricted good against all other goods, equal to the reciprocal of the crossed indifference curve obliquity tangent, starts to grow.

APPRAISAL OF THE DEGREE OF EFFECT MANIFESTATION

The single consumer case

The case of restricted resources consumed individually

In economic textbooks (see, for example, [Nicholson, 1995]) the representation of indifference curves through the assemblage of graphs of equi-potential values of the Cobb-Douglas type utility function

$$U = K \cdot L^{\alpha} \cdot M^{\beta}$$

is very popular as illustrative. Here, K is a non-dimensional constant factor; L is the consumption of one good, for example,

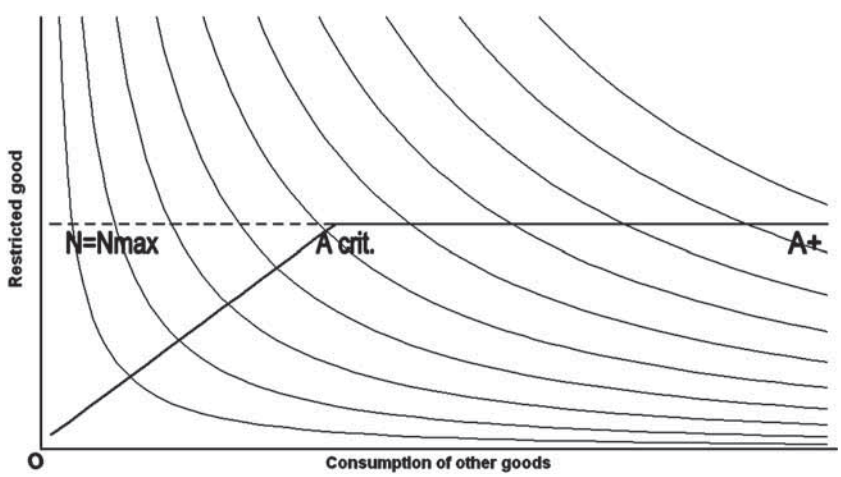

Fig. 2. The indifference curves graph and a consumer choice trajectory when consumption restrictions exist for a fixed chosen good (a case of a homothetic utility function)

quantity of trips to the nature; M is the consumption of another good, in our example, it is the consumption of all other goods estimated by money's worth of the expenses, associated with its realization; α and β are the power indices greater than zero.

Assuming a cost of a trip to a suburb equals p, and general budget spent for the consumption equals B, we arrive at an optimization problem:

$$p \cdot L + M = B$$

$$L \leqslant L_{\max}$$

$$L^{\alpha} \cdot M^{\beta} \to \max.$$

While the budget is does not exceed critical $B_{crit.} = \frac{pL_{\max}(\alpha+\beta)}{\alpha}$, then the solution to this problem will be $L_{opt.} = \frac{\alpha\beta}{(\alpha+\beta)p}$. The marginal value of an additional trip to the nature suburb in the point of the optimum will now be equal to p, i.e., to the costs of its realization. Let now $B > B_{crit}$.

Thereafter,

$$L = L_{max},$$

$$M = B - p \cdot L_{\max},$$

$$V_{L/M} = \frac{\alpha}{\beta} M/L = \frac{\alpha(B - pL_{\max})}{\beta L_{\max}}. \quad (1)$$

If $B = B_{crit.} + \Delta B$, where ΔB is the budget excess above the critical value, we can transform the formula (1) to

$$V_{L/M} = p + \frac{\alpha}{\beta}\frac{\Delta B}{L_{\max}},$$

which evidently shows the dependence of growth of the limited product value beginning from the point of excess over the critical budget: the increase of the value is in direct proportion to the increase of the budget.

THE CASE OF A COMMON-POOL RESOURCE AND A GROWING NUMBER OF CONSUMERS

Let us consider an elementary model of how a renewable common-pool resource (i.e. reproducible, and non-excludable, but rival) with the annual productivity of A units is used.

The annual production of this resource is shared among $N(t)$ members of a local community. Let us assume that the number $N(t)$ grows with time in a geometrical progression

$$N(t) = N_0(1 + \nu)^t.$$

The consumer budget of each community member also grows in a geometrical progression:

$$B(t) = B_0(1 + \gamma)^t.$$

Let us also assume that a) consumption of a common-pool resource has already reached the stage of its possible maximum, and it is equally shared among the community members:

$$A_j(t) = A/N(t),$$

where j is the index of a community individual member; and b) general individual utility from the consumption of an investigated resource and the total consumption of all other goods is described for every community member by the same time-constant utility function of the Cobb-Douglas type:

$$U_j = KL_j^{\alpha} \cdot M_j^{\beta}.$$

Then, for the time moment t: $L_j(t) = A/N(t)$, $M_j(t) = B(t) - p_j(t)L_j(t)$,

$$V_L^j(t) = \frac{\alpha}{\beta}\frac{B_0(1+\gamma)^t - p_j(t)L_j(t)}{L_j(t)} = \frac{\alpha}{\beta}\left(\frac{B_0 N_0 (1+\gamma)^t (1+v)^t}{A} - p_j(t)\right). \quad (2)$$

Here, $p_j(t)$ is the j-th community member's size of expenses for withdrawal or consumption of the last common-pool use resource unit, i. e., is the marginal value of the resource.

If the size of $p_j(t)$ is or eventually becomes negligible in comparison with $\frac{B_0 N_0 (1+\gamma)^t (1+v)^t}{A}$, then the formula (1) can be transformed to the form of

$$V_L^j(t) \cong \frac{\alpha}{\beta} \frac{B_0 N_0}{A} (1+\gamma)^t \cdot (1+v)^t, \quad (3)$$

and the individual coefficient of discounting factor reduction for the resource marginal value will become equal to $(1 + \gamma) \cdot (1 + \nu)$. So, the corresponding discounting factor seems to be equal approximately to $r - (\gamma + \nu)$, where r is the discounting rate for conventional goods in socially-oriented projects.

The degree of effect manifestation for a social community in whole

The case of a common-pool resource

Let us note that formulas (2) and (3) in the assumption of simple additivity, used usually by default, of a public utility function in reference to individual utilities composing it, also give us the appraisal of the effect for the community in whole for the case when the marginal effect of the actions directed on improvement of resource functioning or on reduction of the tendency to its disruption is estimated for a common-pool type of resources, because the arising marginal effect is consumed competitively, i.e. only once, either by strictly one member of the community, or by several members in some proportion.

The case of real public goods

Let now A to be a productivity of a service providing a real public good (i.e. non-rival and non-excludable).

Let us also assume that the consumer budget of each community member also grows in a geometrical progression:

$$B(t) = B_0(1 + \gamma)^t.$$

Furthermore, let assume that a) consumption of a real public good (something like visiting scenic places or enjoying safety from floods) has already reached the stage of admissible maximum (in other words, community members are rich enough to allow themselves some amount of these products, but further rise of their consumption is restricted by non-economic reasons), and all members consume these products to the full extent:

$$A_j(t) = A,$$

where j is the index of a community individual member; and b) the general individual utility from the consumption of an investigated resource L and the total consumption of all other goods M is time-constant and is described for every community member by the same utility function of the Cobb-Douglas type:

$$U_j = K L_j^{\alpha} \cdot M_j^{\beta}.$$

Then for the time moment t: $L_j(t) = A$, $M_j(t) = B(t) - p_j(t) - p_i(t)L_j(t)$,

$$V_L^j(t) = \frac{\alpha}{\beta} \frac{B_0(1+\gamma)^t - p_j(t)A}{A} = \\ = \frac{\alpha}{\beta}\left(\frac{B_0(1+\lambda)^t}{A} - p_j(t)\right)$$

Once again $p_j(t)$ is the j-th community member's size of expenses for consumption of the last unit of public resource, that is, the individual marginal value of the resource.

If the size of $p_j(t)$ is or eventually becomes negligible in comparison with $\frac{B_0(1+\gamma)^t}{A}$, then the formula (4) may be transformed to the form of

$$V_L^j(t) \cong \frac{\alpha}{\beta}\frac{B_0}{A}(1+\gamma)^t,$$

and the ratio to lower the discounting factor for the public resource marginal value will be $(1 + \gamma)$. So the corresponding individual discounting rate will be near $r - \gamma$, where r is the discounting rate for conventional goods in socially-oriented projects.

But, again, if the number $N(t)$ of community members grows in a geometrical progression

$$N(t) = N_0(1 + \nu)^t,$$

the total public marginal value, which is now the sum of the individual values, grows as $\sim (1 + \gamma)^t \cdot (1 + \nu)^t$, and $(1 + \gamma)^t \cdot (1 + \nu)^t$ corresponds to the lowering ratio, and the discounting rate is near $r - (\gamma + \nu)$, that is, the discounting rate for conventional goods in socially-oriented projects minus the rate of growth of the total public consumption.

Important remark

The important remark here is that nature protection projects not so much create ecosystem production and functions, as support and improve their renewal. Therefore, exactly the consideration of the marginal, instead of the average values is valid for the assessment of these goods relatively to the conventional ones.

Consideration for projects that worsen environment conditions

In order to further elaboration on the statements about the distinction between different kinds of discounting rates and to emphasize the need of compensations for natural ecosystems losses during realization of projects that worsen environment conditions, we offer the following formula of settlement payments to ecosystems' proprietors or users from investors in such projects (the case of pure financial indemnifications is considered):

$$\sum_{i-0}^{T} P_i/(1+\theta)^i = \Delta S + \frac{\Delta F}{\eta} + Ex\ .$$

Here ΔS are the losses of "environmental stocks". These are all kinds of the losses associated with non-recurrent incomplete recycling of values of destroyed natural resources, and also with changes in components of the total value: option value, value of current existence, and bequest value. ΔF are losses in "ecological stream", i.e., annual productivity of destroyed plus productivity reduction of disturbed ecosystems. η is the *natural* discounting rate for ecosystem goods expressed in unit fraction. Ex ("externalities") is a current estimation of the difference of the positive and negative external effects connected with the project realization. T is the planned duration of the project realization, i is the number of year of the project realization, at the end of which the payment P_i is made, P_0 is the project starting payment, $1/(1 + \theta)^i$ is the i-th year discounting multiplier for financial indemnifications, and θ is the *financial* rate of discounting, taking into account the inflation.

CONCLUSIONS

The main conclusion derived from the discussions presented above is:

Continuous growth of productivity of human economic activities and continuity of natural ecosystems' specific potential, difficulty of ecosystem production and services replacement and public character of their consumption lead to a naturally occurring distinction between corresponding discounting rates.

The idea of special discount rates for production and non-material services of ecosystems is useful both for economic efficiency assessment of nature conservation activities and for calculation of compensations from the activities that worsen environment quality.

Speaking of perspectives for research in this area, first of all, we note the necessity of specification of real indifference curves and of approaching functional dependences for typical individual and public (if exist) utility functions with inclusion of the quantity of consumed production and services of natural ecosystems as one of the parameters for these functions.

Assessments of investment risks may also become the important direction of development. As an initial frame position of such research, we should mention that in conventional investment projects, the consideration of risks of a project failure or profits cut short leads to increase in the discounting rates for anticipated values. On the contrary, in nature protection projects and projects affecting ecology, risks of irreversible ecosystems' losses, most possibly, should decrease the rates of discounting of the corresponding values produced by the ecosystems. Therefore, distinctions in the risks of the ecosystems' losses and in times of their self-regeneration should lead to a spatial differentiation in corresponding discounting rates. Development of methods for quantitative estimation of resulting effect is necessary.

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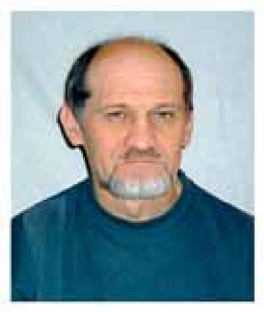

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