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TIME FACTOR IN ECONOMIC VALUATION

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CZYNNIK CZASU W BADANIACH WYCENY EKONOMICZNEJ

STRESZCZENIE: Badania oceniające korzyści czerpane z ekosystemów są obecnie istotną częścią wszystkich badań poświęconych wycenie ekonomicznej. Zjawiskiem niepożądanym jest marginalizowanie czynnika czasu. W artykule skupiono uwagę na pasywnej jak i na aktywnej roli odgrywanej przez czynnik czasu w badaniach wyceny. Przedstawiono analizę dyskontowania, a w szczególności zwrócono uwagę na problem wyboru stopy dyskontowej.

SŁOWA KLUCZOWE: wycena ekonomiczna, dyskontowanie, świadczenia ekosystemów

Introduction

Thanks to economic valuation a lot of intriguing results was worked out and published enlarging our knowledge and understanding of non-market goods and services. Applying economic valuation methods researchers measured consumers' willingness to pay for many goods which do not have any market price. Category of non-market goods includes also environmental goods granted because of the existence and biological production of small and large ecosystems. Among economic valuation studies the most peculiar place belongs to complex studies focused on benefits stemming directly and indirectly from ecosystems.

Unfortunately, time factor used to be marginalized in many valuation studies. This is why this article concentrates on a passive role and also on an active role played by time factor in economic valuation. The paper demands for clear information about the date of implementation of valuation method and also for a more advanced representation of time in valuation studies focused on natural capital. The paper proposes a brief analysis of discounting in general and discusses selection of the discount rate in particular.

A passive role of time factor

Economic valuation studies produce results which need very careful and precise interpreting. Interpretation is not easy because of an inappropriate treatment of time factor. Basically, time plays in valuation process a passive role and also an active role.

In its passive role, time is just a precise information "when" the valuation research was performed. Simultaneously, this is also an implicit information about multiple market-specific relationships. First and direct relationship creates correspondence to all prices of other goods which are available on the market including substitutes and/or complementary goods. Moreover, this relationship includes also, implicitly, a hint on trade-offs between valuated good and regular market goods.

Obviously, economic valuation occurs in one strictly defined moment or period. In its passive condition, time is represented by the calendar date. The research itself reveals the value of a non-market good but this assessed value is constrained to a very limited period and space. In other words, information on timing is an important part of the context "label" giving an insight into the technical parameters of any valuation research.

However, this quite basic meaning of time has also its important consequences for the result. The number being an outcome of any valuation study has its significance and validity which is no more stable and no more reliable than any

other dynamically evolving market price. There is nothing like universal, fixed and true valuation assessment. Calendar date, place, sample, and applied methodology determine the context, thus, they contribute to the result of calculation. It is crucial that some contextual elements like place, sample and method can be, more or less exactly, replicated in the future. However, the identity created by the moment of time remains unique both in material and in philosophical sense.

Monetary assessments still experience rather limited understanding and confidence. This is one more argument why it is evidently important to eliminate valuations without transparently explained context from any serious scientific discourse. In principle, economic values which are lacking calendar date, are not up-dated, are wrongly transferred from other studies, or are presented without necessary disclosure of their methodology may create, per balance, more problems than cognitive benefits.

It is always a matter of professionalism and responsibility of researcher to find out to what extend existing economic valuation assessments are still valid and can constitute reliable and significant arguments. In conclusion to the passive role of time factor, it should be requested that each economic valuation attempt has to be supplemented by its technical description. This "label" should inform on the context ("why", "what", "where", "how") with a clearly expressed calendar date ("when").

An active role of time factor

The problem of time is much more sophisticated with regard to an active role of time factor. This statement is justified by a common fact: some costs and benefits generated by non-market good have their complex distribution in time. Quite often, costs and benefits can be observed every day and year by year what suggests that researcher has to decide about the present value of future costs and benefits. This calls for discounting calculation which is quite indisputable in the case of market goods but not easy in the case of natural environment and some non-market artifacts. An active role of time factor becomes extremely crucial when time horizon of the study is very long and concerns future generations. This observation applies also to the case when irreversibility phenomenon occurs and makes its impossible to consume some goods in the future.

Economic valuation remains still a lovely domain of academic studies. It is very popular topic among students writing their master or doctoral thesis but at the same time this topic occupies a marginal place in real-life economics and economic decision making. It is very likely that more intensive and practical applicability of empirical valuation to day-to-day practice of insurance business and its compensation schemes would result much earlier in a more careful treatment of time factor. Unfortunately, it did never happen on a large scale.

Therefore, the following five questions should be addressed to improve the theory and practice of time perception in valuation studies:

1) Do considered benefits and costs occur only once or do they take a form of a stream in a course of time and their volume will be of varying intensity?
2) Are we in a position to foresee physical quantities of benefits and losses which will occur in the future and assess their monetary value?
3) Can we define discount rates which will be appropriate coefficients for any defined time horizon of the study?
4) What kind of correction will be needed for discounting when the time horizon is extremely long or infinite?
5) How to proceed with discounting when irreversibility phenomenon causes that some benefits will never occur in the future?

Questions enumerated above will be developed a bit in the next section of this paper. However, it is perfectly clear that do not exist perfect answers to all these questions. This paper does not pretend to give final and universal ("one size fits all") prescription for valuation studies but rather wants to encourage further debate and some improvement.

In addition, non-market goods do not create any homogeneous category. In particular, ecosystem services are not isolated from their ambient and have a long term impact on biosphere, society and economy. Moreover, time horizon in the case of benefits from ecosystem services exceeds standard time horizon appropriate for economic investment. Obviously, ecosystem services perspective goes beyond a regular time-span of strategic documents which used to be limited to a period of 20-25 years. Thus, it seems to be too trivial and artificial to limit valuation practice to an assessment of willingness to pay for an isolated, one-time (just today) and on spot transaction.

Discounting and discount rate

Discounting is the process of expressing future values in present value terms which allow for the comparison of cost and benefit flows regardless of when they occur. It sounds to be a realistic and logic observation that people, in general, do prefer experience benefits now and paying costs in the far future. The present value of a future flow of benefit or cost will be lower than the future value because of discounting. The mathematics of discounting meets a lot of criticism[1], mostly expressed by non-economists, and any discounting with non-zero discount rate can be accused to promote so called "tyranny of the present".

This problem is very transparent and hot in the environmental management. Discounting the value of one development project's future environmental benefits makes their future value disappointingly low compared to the present costs of ensuring them for the next generation. The same controversy applies to dis-

[1] B. S. Matulis, *The economic valuation of nature: A question of justice?*, "Ecological Economics" 2014 no. 104, p. 155-157.

counted value of a development project's future environmental damage which will be drastically low compared to the present cost of avoiding it.

"Discounting can easily become a pseudoscientific way of making the ethical judgment that the future is not worth anything"[2]. This opinion of Herman Daly[3], one of the most influential ecological economists, should raise our attention. Daly gives one strong argument why the attempt of standard economics to solve the intergenerational distribution problem by a market driven discounting is illegitimate: "The discount rate (interest rate) is a price, and like all prices it is determined subject to a given distribution of income and a given scale of the macro economy. Different distributions of the ownership of the resource base over generations, and a different scale of the macro economy, will result in different prices, including different interest rates. Since the interest rate is determined by the scale and intergenerational distribution of the resource base, it cannot be used as the criterion for determining either scale or intergenerational distribution via discounting. To do so would be circular reasoning"[4].

In principle, the problem with intergenerational equity is rather a normative economic ethics than pure microeconomics. Using market rates of interest as a guide to setting discount rates does not necessarily distribute the burdens and benefits of investment decision fairly between the present and the future. The supposed basis of markets is the self-interested actions of mortal individuals. The notion of discounted present value represents "the value to present people derived from contemplating the welfare of future people. It does not reflect the welfare of future people themselves, or even our estimate of their welfare. Rather it reflects how much we care about future people compared to ourselves"[5]. However, communities outlive their individual members and what may make sense for individuals seeking to maximize short-term present value may threaten the long-range interests of communities.

In his conclusion, Daly is extremely critical with respect to discounting as a panacea for intergenerational distribution and scale problems: "Standard economics routinely seeks to solve the intergenerational distribution problem by discounting, as if it were a single generational problem of inter-temporal allocation of consumption over the life stages of a single group of individuals, forgetting that different generations are different people and therefore the problem is one of just distribution, not efficient allocation. (…) Ecological economics insists on the basic distinction between allocation and distribution, and even for single-generation temporal allocation suggests the logistic rather than the exponential function as a more realistic representation of how people actually relate present and future value"[6].

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[2] T. Prugh et al., *Natural Capital and Human Economic Survival*, Solomons 1995, p. 98.
[3] H. E. Daly, *Steady-State Economics*, Washington 1991.
[4] H. Daly, *Ecological economics and sustainable development. Selected essays of herman daly*, Cheltenham 2007, p. 29.
[5] H. E. Daly, J. Cobb, *For the common good: redirecting the economy toward community, the environment and a sustainable future*, Boston 1989, p. 154.
[6] H.E. Daly, *Ecological economics …*, op. cit., p. 253.

In economics, exponential discounting is a specific form of the discount function, used in the analysis of choice over time. Exponential discounting implies that the marginal rate of substitution between consumption at any pair of points in time depends only on how far apart those two points are. For its simplicity, the exponential discounting assumption is the most commonly used in economics. However, alternatives like hyperbolic discounting have more empirical support.

Hyperbolic discounting is a time-inconsistent model of discounting. A large number of studies have since demonstrated that the constant discount rate assumed in exponential discounting is systematically being violated[7]. Hyperbolic discounting is a particular mathematical model devised as an empirically based improvement over exponential discounting, in the sense that it better fits the experimental data about actual behavior.

There is some empirical evidence in economic valuation studies that criticism of discounting in a form of the inverse of the exponential function was right[8]. For instance, in the case of future safety effects, it seems reasonable to assume that an individual's anticipated utility loss associated with the prospect of premature death (or injury) remains effectively constant over time. There is also some evidence that individuals do discount the future "hyperbolically" rather than "exponentially". The evidence comes from several psychological and medical studies.

In hyperbolic discounting, valuations fall very rapidly for small delay periods, but then fall slowly for longer delay periods. This contrasts with exponential discounting, in which valuation falls by a constant factor per unit delay, regardless of the total length of the delay. However, the time inconsistency of this behavior has some quite perverse consequences[9]. Individuals using hyperbolic discounting in their decision making reveal a strong tendency to make choices today that their future self would prefer not to have made, despite using the same reasoning[10].

Simultaneously, a good number of new studies wants to address adoption of the discount rate in a more complex way. The study by Daniel Read introduces "subadditive discounting"[11] where discounting over a delay increases if the delay is divided into smaller intervals. This sophisticated hypothesis may explain the main finding of many studies in support of hyperbolic discounting – the observation that impatience declines with time – while also accounting for new and unconventional observations not predicted by hyperbolic discounting.

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[7] S. Frederick, G. Loewenstein, T. O'Donoghue, *Time discounting and time preferences: a critical review*, "Journal of Economic Literature" 2002 no. 40, p. 351-401.

[8] I. J. Bateman et al., *Economic valuation with stated preference techniques*, Cheltenham 2002.

[9] The standard experiment used to compare short-term preferences with long-term preferences. For instance: "Would you prefer a dollar today or two dollars tomorrow?" or "Would you prefer a dollar in one year or two dollars in one year and one day?" For certain range of offerings, a significant fraction of subjects will take the lesser amount today, but will gladly wait one extra day in a year in order to receive the higher amount instead.

[10] D. Laibson, *Golden eggs and hyperbolic discounting*, "Quarterly Journal of Economics" 1997 no. 112, v. 2, p. 443-477.

[11] D. Read, *Is time-discounting hyperbolic or subadditive?*, "Journal of Risk and Uncertainty" 2001 no. 23, v. 1, p. 5-32.

There is also a "component based" approach providing a rationale for social discounting within the natural resource damage assessment[12]. "The proposed approach is a combination of some theoretical foundations of dual-rate discounting and time-declining social discounting. The former provides the principle that different discount rates should be used when considering either tangible (cost components) or medium-long term intangible effects (i.e. welfare losses), the latter that uncertainty and intergenerational equity issues play in favor of time-declining social discount rates"[13]. This approach agrees on the principle that very long-term welfare losses have to be discounted at low rate in order to mitigate the "tyranny of the present" effect. As a result, each damage component is discounted with a constant separate rate chosen from a menu of declining rates prescribed by the government. The choice of the rate is anchored to the damage component duration.

The consistency of optimal growth and sustainable growth depends very much on the relationship between the productivity of the resource base and the social discount rate. The higher the discount rate, the more is sustainable development at risk from the deliberate planning of "optimal" growth. The lower the discount rate, the less is the risk of "optimal extinction" for future generations. In particular, discounting is consistent with the sustainable use of renewable resource as long as the discount rate does not exceed the regeneration rate of the resource[14].

Obviously, for a non-renewable resource, regeneration is zero and there is no sustainable rate of consumption when the resource base consists solely of a non-renewable resource in fixed supply. Discounting merely brings forward the day when consumption falls to zero. Hence, the discount rate can have a profound implications for sustainable development. Hotelling's rule requires that resource rents in an efficient market will increase at the rate of exchange equal to the interest rate. This economic concept considers more profoundly economic efficiency conditions and gives less attention to physical constraints and multiplied consequences of scarcity of the resource.

The choice of rapid-exploitation, slow-exploitation, or non-exploitation depends crucially on the discount rate. The discount rate reflects the long-term profitability of different investments. Sustainability objectives could thus be introduced into investment decisions by stipulating a "social" discount rate for the use of environmental assets. The social discount rate would usually be lower than the market one to ensure the availability of natural resources assets for future generations. However, the rate is difficult to determine. Moreover, the normative (ethical) choice of low social discount rate for international and intergenerational equity takes a risk to be very discretionary. As a result, if it is not firmly

[12] E. Defrancesco, P. Gatto, P. Rosato, *A component based approach to discounting for natural resource damage assessment*, "Ecological Economics" 2014 no. 99, p. 1-9.
[13] Ibidem, p. 7.
[14] C. W. Clark, *Mathematical bioeconomics*, New York 1990.

founded in the theory, it may raise even more objections and receive more negative opinions than the regular market discount rate.

While a range of discount rates is possible, growth theory suggests that the social rate of return on investment is equal to the current social discount rate expressed by the following formula: $s = r + u \cdot \hat{c}$, and here: r – is the pure rate of time preference (or rate of impatience, the rate at which future utility is discounted), u – is the elasticity of the marginal utility of consumption, $\hat{c}$ – is the percentage rate of growth in per capita real consumption or its equivalent. It should be stressed again that "r" may be based on the myopic notion of "pure" time preference, as well as the risk perception that future consumption will never take into account.

The key point is that it may be misleading to choose discount rates without assuming some consistent scenario. The main obstacle is that the social discount rate needs empirical research and coefficients of elasticity of the marginal utility of consumption. The second best solution is to agree that the social rate of discount is equal to the growth rate of real consumption per capita or its close equivalent. Familiar approach was applied to the calculation of future costs and benefits resulting from the climate change policy. In particular, the growth rate of world GDP was supposed to indicate the global social discount rate.

Some recent studies suggested that it is inappropriate to use the same annual discount rate into the distant future. Weitzman (2001) argued that serious uncertainties about future economic magnitudes imply smaller discount rates as one imagines years deeper into the future[15]. Davidson published that zero discounting can compensate future generations for climate change[16]. In turn, Frederick et al. (2002) have published a survey of empirical evidence that tends to undermine traditional time discounting altogether[17].

It is worth mentioning that economists are not unanimous on the effect of interest and discount rates on natural capital management, even when they are sympathetic to the need to conserve natural capital. Some argue that although high interest rates tend to encourage depletion of resources now and thus shift ecological costs to the future, high rates also discourage investment in general, since it costs too much to borrow money and few projects will earn a high enough return to pay off loans or compete with leaving the money in the bank. Since natural capital is necessary for investment, when investment is low, so is the demand for natural capital. Thus, Pearce and Turner conclude: "exactly how the choice of discount rate impacts on the overall profile of natural resource and environment use in any country is ambiguous"[18].

"In the economists' perfect world, the market discount rate and the discount rate required for sustainability are brought into equilibrium, provided society

[15] M. L. Weitzman, *Gamma discounting*, "American Economic Review" 2001 no. 91, p. 260-271.
[16] M. D. Davidson, *Zero discounting can compensate future generations for climate change*, "Ecological Economics" 2014 no. 105, p. 40-47.
[17] S. Frederick, G. Loewenstein, T. O'Donoghue, *Time discounting and time preferences: a critical review*, "Journal of Economic Literature" 2002 no. 40, p. 351-401.
[18] D. Pearce, R. Turner, *Economics of natural resources and the environment*, Baltimore 1990, p. 224.

maximizes some inter temporal welfare function and is operating at the boundary of an inter temporal production possibility frontier. But there are many distortions that are likely to force market rates to be above the "true" marginal product of capital. (…) This implies that the social discount rate will be below that produced by market forces"[19].

These considerations suggest that sustainability can be more guaranteed if the "true" value of marginal capital productivity could be determined and be used as the actual discount rate, and if the economy is not heavily reliant upon non-renewable resources. Ecological economists pay much attention to the principles of sustainable development. They argue that it would be better to build sustainability into economic decisions by setting an a priori requirement that the total stock of natural capital be left constant, regardless of the other benefits and costs[20]. Certainly, sustainability criterion would suggest the discount rate differing from market discount rate.

Aiming to conclusions, it should be stressed that in business practice discount rates are set more or less equal to prevailing rates of interest and exponential discounting is most widely used. In contrast to this, hyperbolic discounting is an alternative in a form of "slow discounting" such that the future is discounted at a rate less than that implied by exponential discounting. It is worth mentioning that stated preferences valuation techniques may be used to derive discount rates[21].

In general, discounting with market discount rates has extremely significant, far reaching and negative consequences for all non-market goods. In particular, a lot of environmental non-market goods, and ecosystem services, occur outside the market and without legally confirmed ownership what implies overexploitation. Daly's reservation concerning the distribution of benefits explains that using market discount rates for environmental non-market goods is not fair with regard to the future generations.

Summarizing, it should be stressed that there is no a priori and correct way to discount all future gains and losses. Sustainability concept opens new opportunities for discounting and there is both reason and room for maneuver in selecting discount rates. On the one hand, concerns such as those discussed above prompt some environmentalists to urge use of low rates with projects entailing large environmental impact. On the other hand, however, subjective and too much relaxed choice of discount rate tends to be very discretionary, thus, a controversial and politicized process.

[19] G. Atkinson et al., *Measuring sustainable development. Macroeconomics and the environment*, Cheltenham 1997, p. 5.
[20] Ph. Lawn (ed.), *Sustainable development indicators in ecological economics*, Cheltenham 2006.
[21] I. J. Bateman et al., *Economic valuation with stated preference techniques*, Cheltenham 2002.

Conclusions

The strength of the economic valuation methods is that their concept of value incorporates the relationship between humankind and ecosystem products. However, the economic valuation methods also face severe difficulties. Often they do not adequately take account of the internal structure of ecosystems. Hence, they neglect the ecological interdependencies of different ecosystem entities. As many of the ecosystem services have public good properties, there is no simple way to imitate markets for these services. Therefore, there is also a place for ecological valuation methods in physical units[22].

Valuation of ecosystem services experience time factor in two ways. Firstly, valuation is very specific with regard to timing of the study. Thus, assessed economic value has to be clearly identified by its contextual "label". Role of this label is to declare openly all details about the method used for valuation including information when the survey was conducted. Secondly, managed ecosystem services[23] should be examined as streams of benefits. Thus, without anthropogenic damages or natural turbulences ecosystem services will be delivered now and will be delivered in the future. This feature has to be represented in economic valuation and aggregated over time, especially in all attempts to valuate the natural capital.

Our human impatience and hedonic reasoning about the future will always support decision on discounting but policy oriented on non-market environmental goods and public goods (e.g. sustainable development) can modify market discount rates. However, the decision how the discount rate for ecosystem services should be defined is not obvious and has not been made yet, thus, this issue will require intensive research.

[22] The ecological valuation methods are either based on an energy theory of value or on an economic-ecological analogy. They are clarified in: R. Winkler, *Valuation of ecosystem goods and services. Part I: An integrated dynamic approach*, "Ecological Economics" 2006 no. 59, v. 1, p. 82-93.

[23] It seems to be both important and stimulating to develop discussion on difficulties associated with the provision of ecosystem services. Because, "to understand the processes, it is necessary to clearly distinguish ecosystem functions, ecosystem service potential and ecosystem services" (J. H. Spangenberg, Ch. von Haaren, J. Settele, *The ecosystem service cascade: Further developing the metaphor. Integrating societal processes to accommodate social processes and planning, and the case of bioenergy*, "Ecological Economics" 2014 no. 104, p. 31).