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TIME, DISCOUNT RATE AND PUBLIC DECISION-MAKING

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TIME, DISCOUNT RATE AND PUBLIC DECISION-MAKING

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Abstract

In this paper two issues regarding time preference in the economic analysis of public investment projects will be treated simultaneously, viz. a critical review of the literature on the use and the value of the social rate of discount, and a review of arguments advocating the use of flexible discount rates.
The paper will try to critically discuss the literature from three perspectives, viz. time preference (including intergenerational distribution), opportunity costs, and risk behaviour. It will be demonstrated that - depending on policy objectives and specific circumstances - a variable discount rate may well be defended on economic grounds. The paper presents also an attempt at incorporating a social welfare approach (including inter alia consumption, uncertainty, multiple generations, and externalities) in public project evaluation. Here it is shown that - under fairly general circumstances - a variable discount rate is in agreement with a social welfare approach.

1. Introduction

The element of time has two dimensions in economic analysis, viz. as a scarce commodity and as the multi-period trajectory along which the impacts of economic activities are spread out.

The first dimension is extensively studied in the economics of leisure time (e.g., recreation economics) and of job search behaviour. In this context it is taken for granted that leisure time is a constituent of (individual or social) welfare, so that the maximization of welfare has to take place subject to a set of constraints among which income and time are the most prominent ones. Time is then essentially regarded as a commodity to be consumed: more leisure time will increase somebody's welfare, but will on the other hand leave less possibilities for earning income (thus leading to a decline in welfare). Consequently, leisure time and income are to some extent substitutes, so that utility maximization has to include a trade-off between these different welfare components. This trade-off has no doubt important implications for housing search behaviour and its related labour market and traffic aspects. As this field of analysis is well developed in economics, no further attention will be given to this issue in the present paper.

The second dimension, viz. the multi-period trajectory of impacts of economic activities, takes for granted that welfare has to be measured essentially along a long-term evolutionary path (either as a continuum or as a series of subsequent discrete time intervals). Furthermore, it is worth noting that in general the (individual or social) utility of a good or service declines over time, if its actual use has to be postponed. In other words, in order to judge the present utility of a good or service which becomes available at a certain later point in time, a so-called rate of discount has to be applied in order to calculate its present value. The analysis of this problem of a discount rate has already a long history in economics; it has been studied extensively in financial economics in relation to decisions of private entrepreneurs, and in welfare economics in relation to decisions of public agencies.

In the 1920s already, various economists (Hotelling, Pigou, Ramsey) have devoted attention to time preferences in economic choice analysis (see also Heal, 1981). Especially Pigou has called attention for the problem of myopic behaviour of an individual decision-maker suffering from a faulty telescopic faculty, necessitating a government to counteract the citizens' short-sightedness. Since the 1970s this issue of efficiency and equity has again become prominent in economic analysis. In the literature two main streams may be distinguished in the framework of long-term public decision-making, viz. a Utilitarian and a Rawlsian viewpoint (cf. also Grout, 1971).

Briefly speaking, a Utilitarian view on long-run planning would suggest a course of action which would maximize all net benefits to all people involved during the whole planning period. Assuming a certain weight for the future streams of benefits (i.e., a social rate of discount), the Utilitarian framework constitutes essentially the foundation of modern social cost-benefit analysis based on efficiency considerations.

A Rawlsian approach is essentially more distribution-oriented, as it states inter alia that social and economic inequalities are to be arranged so that they are to the greatest benefit of the least advantaged (see Rawls, 1972). This maxmin principle of justice could also be applied in an intertemporal context by stating that especially those public policies should be pursued that maximize within a certain planning horizon the well-being of those individuals or groups with minimum well-being. Rawls' social justice theory has been elaborated by Solow (1974) for a situation with multiple generations. He formulated an optimum control maximum principle for intergenerational distribution, viz., maximize the welfare of that generation which derives the lowest welfare level from the consumption of a finite stock of resources. A reformulation of the result of a Rawlsian approach in terms of a Utilitarian framework would no doubt mean a flexible social rate of discount which has to be adjusted in each planning period.

The difference between the Utilitarian efficiency principle and the Rawlsian equity principle has been a source of controversies in economic thinking and is also one of the causes of diverging views on the use and relevance of the social rate of discount. Both the question of a fixed or flexible social discount rate and the determination of the optimal value of this discount rate are related to market-oriented efficiency criteria and to socially-oriented distribution criteria for the evaluation of multi-temporal utility streams of individuals, groups or society as a whole. Thus the socio-economic meaning of time preference is at stake in this discussion.

The present paper will mainly pay attention to two interconnected issues regarding time preferences in the economic analysis of public investments, viz. the use and value of the social rate of discount, and the need for a variable (or flexible) social discount rate in public decision-making.

First, the literature on long-term planning and related social rates of discount will briefly, systematically and critically be reviewed from three perspectives, viz. social time preference (including intergenerational distribution), opportunity costs (e.g., in terms of alternative uses of scarce resources), and risk behaviour based on lack of information. It will be demonstrated that - depending on specific public projects, policy objectives and/or circumstances - a variable discount rate may be justified on economic grounds. Finally, the paper provides also a brief

discussion of a social welfare approach to long-term public decision-making (including consumption growth, uncertainty, multiple generations and externalities). It is shown here that - under fairly general circumstances - a variable discount rate is in agreement with a social welfare approach.

2. The Social Rate of Discount

In evaluating public projects (e.g., irrigation plans, social security systems, educational systems, infrastructure plans) which cover multiple time periods, one is usually confronted with the question as to how to evaluate the advantages and disadvantages of such projects over a series of years. Three problems emerge in this framework: (1) the precise assessment of all impacts of each of these projects; (2) the translation of these impacts into a monetary denominator in order to gauge in each period the costs and benefits of these projects; and (3) the assignment of weights to the annual flows of costs and benefits in order to calculate the present value of the whole project (the problem of the social rate of discount).

The aggregate weighted flows of all costs and benefits leads to the net present value of the project concerned. If one adopts the efficiency criterion that projects have to be selected on the basis of their contribution to the total net present value, one may use the following formal decision criterion:

$$Y = \sum_{t=1}^{T} (B_t - C_t)/(1+r)^t \quad ,$$

where:

Y = net present value

B = monetary benefits

C = monetary costs

r = social rate of discount

t = time period

The abovementioned weights are in fact equal to $1/(1+r)^t$. Clearly, the problem of a multi-period evaluation of public projects boils essentially down to the assessment of these weights. This is an intriguing question, as the selection of a public project will - to some extent - depend on the value of the social rate of discount. A theoretically justifiable and unambiguous value of the social rate of discount is however hard to find. In many cases (for instance, project evaluation by the World Bank) ad hoc rules are adopted, based on uniform discounting percentages (e.g. a value of 10 percent). Such uniform discounting principles have unfortunately two disadvantages: (1) they favour only projects with short - and medium-term benefits, while long-term benefits are not taken into account due to a high social rate of discount; (2) they do not take into consideration specific circumstances, specific policy objectives, or lack of insight, and hence are not tailor-made with respect to specific projects.

Theoretically, the assessment of the optimum social rate of discount may be based on classical consumer theory, in which the decision to realize or to postpone the consumption of a good or service depends on the preference structure of the actor

at hand. In a multi-period situation, the slope of an indifference curve (reflecting the marginal rate of substitution of current for future consumption) corresponds to the rate of time preference, on which basis it may be decided how many units of a commodity will be consumed in subsequent periods. Generally, people prefer current to future consumption, so that this positive rate of time preference implies that future flows of consumption have to be discounted in order to determine their present value.

If the foregoing ideas are applied to public decision-making, it is evident that a government has to take into consideration the society's interest in present and future consumption. In view of the (frequently assumed) myopic behaviour of individuals, it is then usually taken for granted that - especially in a long-term planning context (e.g., resource management) - a government has to base its decisions on a longer planning horizon and on a deeper concern for future generations than is normally done in individual decision-making. This leads to the question whether in public decision-making a social rate of discount should be used that is lower than the (individual) opportunity cost of postponing the consumption of goods or services. There is a vast amount of literature on these aspects of the social rate of discount, but so far no consensus has been reached about the proper value of this discount rate due to lack of insight into externalities, risks, impacts of taxation, financial mechanisms on capital markets, social time preferences, and interests of future generations (see also Nijkamp and Rouwendal, 1985).

In the light of the previous remarks the question may be raised whether the usual market rate of interest may be a reasonable proxy for the social rate of discount. This seems to be a plausible choice, as the market rate of interest may be regarded as the profitability attached by society to a certain capital investment. Consequently, it is sometimes claimed that an allocative efficiency for public resources can be reached by imposing the same profitability criteria as for the private sector. However, various (theoretical and practical) objections can be raised against an approximation of the social rate of discount via the market rate of interest, some of them will be mentioned here.

- the market rate of interest is co-determined by time preferences of individuals who are not necessarily concerned with future interests of themselves or of society as a whole. Immediate consumption is preferred to future consumption of the same quantity of goods, so that the intertemporal allocation of scarce resources is unevenly distributed in the detriment of future generations. Thus the market rate of interest is in itself not optimal, so that its use in the context of public choice behaviour may do harm to the next generation: its value is than higher than the level which would correspond to long-term socio-economic interests.

- the market rate of interest does not adequately reflect the opportunity costs of public projects. In general, the scarce resources spent on a public project are only profitable if they yield higher socio-economic benefits than when these resources would have been used in the private sector. Due to the disturbing effects of taxes and due to substitution effects between public investments and public consumption, the market rate of interest does not adequately represent the opportunity costs of a public project.
- the risk inherent in public projects is of a different nature than that in private investments. First, public projects are more diversified than private investments, and secondly there is a higher spread of risks in investments in the public sector. As such risks have different consequences compared to the private sector, the market rate of interest is not a good proxy for the social rate of discount in case of risky public projects.

The foregoing arguments have demonstrated the inadequacy of the use of the market rate of interest as a proxy for the social rate of discount. In the light of this problem, two different viewpoints regarding the determination of the social rate of discount can be distinguished. The first one is very much ad hoc, and uses a fixed rate of discount for all public projects irrespective of their specific features (like risks, planning horizon etc.). This provides a solid basis for a cross-comparative consistency in the evaluation of different projects, but it neglects the specificity and uniqueness of various public projects, so that various important long-term socio-economic benefits may get lost. The second option is to use a flexible social discount rate, depending on the duration of the project, the concern for future generations, and specific attributes or impacts of the project concerned. In the sequel the attention will mainly be focused on the latter issue. Three different aspects will successively be discussed, viz. time preference and multiple generations (section 3), opportunity costs (section 4) and risk elements (section 5).

3. Time Preference and Future Generations

Instantaneous need satisfaction is a form of (socio-) psychological impatience with far-reaching economic consequences. It means that a postponement of current consumption toward a future period is only acceptable if its resulting welfare loss is compensated for by means of a 'shadow price' (or social rate of discount) reflecting the economic sacrifice of this welfare loss. Consequently, the present value of one unit of consumption in period t has a higher value than that in period $t+\tau$ ($\tau \geq 1$). In this section various types of impatience and its economic consequences will briefly be discussed, followed by a concise systematic review of the literature.

3.1. Pure Impatience

Assume a stationary economy marked by exactly equal conditions (economic prospects, preference structures etc.) in the time interval $[t, t+\tau]$. Society in this period can make a choice between consuming x units of goods either now or later, while it does not have the possibility to put the resources concerned in a savings bank. In this case impatience is the only justification for preferring immediate consumption. This leads of course to a situation where the intertemporal allocation of resources is in favour of current periods.

It should be added however that various situations can be imagined where it is reasonable to postpone immediate consumption (e.g., in cases of satiation). This implies of course a negative time preference. In general, however, it is assumed that people have a positive time preference, caused by some degree of impatience.

The consequence of this impatience is that future interests (e.g., of next generations) are systematically and structurally overlooked, as the level of savings and hence of investments is too low. A government which aims at achieving a maximum welfare for both the present and the next generation should try to restore the balance by discouraging the effects of impatience through the use of a social rate of discount which is lower than the normal market rate of interest.

One of the most well-known representatives of this view was Pigou (1924), who stated that 'defective telescopic faculty' caused (irrational) patience of society. The government - being the 'trustee for unborn generations' - should then try to interfere in favour of future generations. Similar views have also been expressed by previous economists (e.g., Marshall, Bentham), who drew attention to the lack of concern for the future (reflected inter alia in the low savings rate of low income groups). In this framework it was assumed that an increase in welfare would also reduce the degree of impatience (cf. Blaug, 1978, p. 530).

In the post-war period less attention has been paid by economists to situations of pure impatience. Even the term 'impatience' was increasingly substituted by the more neutral concept of 'time preference'. Whether this situation confirms Marshall's view that the phenomenon of impatience will disappear with a further increase in welfare is however hard to demonstrate, as economists appear to defend contrasting views on this phenomenon. For instance, Stigler and Becker (1977) claim that this phenomenon is not relevant anymore, whereas Olson and Bailey (1981) claim that they have convincingly demonstrated its existence and relevance. It should be noted however, that in any case the assumption of an increase in welfare violates the ceteris paribus conditions of the pure impatience case. This issue will be further taken up in the next subsection.

3.2. Economic growth

Assume a society without pure impatience, but facing a situation of (expected) economic growth. If in a situation with rising incomes one has to choose between x units of extra consumption now or later, and if one assumes the (usual) case of declining marginal utilities, it is clear that current consumption will be preferred to future consumption, as the extra utility is at present higher than in the future (cf. Blaug, 1978, p. 528). In this case, the time preference is in agreement with rational behaviour and an optimal allocation of resources. The interest of future generations is not affected and there is no need for government intervention.

In conclusion, time preferences are - in a situation of economic growth - not necessarily detrimental to the interest of the next generation.

3.3. Limited lifetime

It is worth noting, that there is an intermediate case between choice behaviour based on pure impatience and economic growth, viz. the case of a limited lifetime. If an individual expects to die (with a certain probability) in the time interval $[t, t+\tau]$, it is plausible that a rational person chooses in favour of more short-term consumption (despite the future prospects of a higher income level). This is a good example of rational risk-avoiding behaviour at the individual level.

It is however an intriguing question, whether this kind of individual rationality is favourable for society as a whole. Seen from the viewpoint of society as a whole, individual instantaneous consumption is not in agreement with the interest of future generations: individuals die, but society remains! In other words, in a stationary economic situation society is neutral with respect to current or future flows of extra consumption. Thus the multi-period allocation of resources in an

economy is biased toward the short-run interest of rational individuals. This situation may also justify public intervention in view of future interests (cf. Mueller, 1974).

3.4. Distributional aspects of multi-period savings behaviour

A valid counter-argument against the short-term rationality motive of individuals is that most individuals base their consumption decisions to some extent on social considerations regarding their children and/or grandchildren, so that this kind of (rational) social behaviour will reduce the effects of the limited life time argument. However, in this context Sen (1961, 1967) has argued that only part of somebody's current savings will favour his own (grand)children due to the re-distribution mechanism implied by succession rights. Due to the limited long-term impact of such social motives, the present generation's propensity to save may still be relatively low.

Thus society as a whole is facing a difficult choice problem: if nobody would save, the interests of future generations would be dramatically affected. This situation is essentially a case of a free-riders problem: a strategic choice in favour of deviant (i.e., non-joining or non-cooperative) behaviour is only profitable, if the majority of actors adopts the same strategy. In our case, a free riders' strategy caused by the financial redistribution mechanism may discourage the savings propensity of society as a whole, so that this may be a reason for the government to actively stimulate savings behaviour in order to protect the interests of the next generations.

3.5. Concluding remarks

From the previous observations it may be concluded that the interest rate may be too high to be in agreement with the interest of future generations, although this view is sometimes questioned (see for instance Stiglitz, 1982). In this framework a major problem is the lack of consensus on the value of the social rate of discount reflecting the time preference of society. Furthermore, in a representative democratic system composed of short-term oriented individuals it will be difficult for a government to legitimate itself as a trustee for unborn generations. At best the motive of coping with the free riders problem may be used as a valid argument for public intervention, as this problem is the result of a succession legislation edicted by the government itself. Consequently, in many cases the treatment of the interests of future generations is in the first place a matter of altruism and benevolence of the present generation (see also Kirsch, 1984).

In this context Marglin (1963a) has made a distinction between two types of behaviour of 'the same individual',viz. egocentric behaviour prevailing in normal economic market behaviour, and altruistic behaviour prevailing in socio-political evaluation processes. This distinction may clarify that people marked by (irrational) impatience (reflected also in their savings behaviour and concern for new generations)

support a government that regards the concern for the future as an explicit policy aim.

The concern for future generations presupposes insight into their interests (which is an almost impossible task). Of course, one may assume that the interests of the present and future generation are the same, so that one may apply the analysis of intra-generational distribution problems to that of inter-generational ones (see, for instance, Mueller, 1974, Pearce, 1983, and Solow, 1974), but such attempts did not appear to be very successful or realistic. Given the lack of insight into future developments and into the needs of future generations, it was claimed by Sen (1982) that it is a meaningful current policy strategy to keep as many options open as possible for future generations.

An alternative approach was proposed by Iwema and Klaassen (1981) and Rouwendal and Nijkamp (1984), who made an attempt at assessing the explicit long-term impacts of a public project for future generations, so that by means of a trade-off system (based on specific generational discount rates) the various effects could be evaluated with respect to each other. In this framework even situations with overlapping generations can be taken into consideration (see Rouwendal and Nijkamp, 1984).

3.6. Compact literature survey

After the presentation of various aspects of time preference in the evaluation of public decisions, Table 1 gives now a brief systematic presentation of a (selected and non-exhaustive) set of views by different authors (in alphabetic order) on time preference analysis in public decision-making, with particular emphasis on intergenerational allocation of resources. Clearly, this concise presentation does not entirely do justice to the various considerations of the respective authors.

authors	pure impatience (subsection 3.1)	economic growth (subsection 3.2)	limited lifetime (subsection 3.3)	distributional aspects (subsection 3.4)	intergenerational allocation
Feldstein (1964)	+	+			
Harrison (1981)	-	+	-		
Iwema & Klaassen (1981)					+
Kirsch (1984)					+
Kula (1985)		+	+		
Marglin (1963a)	-				
Mueller (1974)			-		+
Pearce (1983)					+
Pigou (1920)	-				
Ramsey (1928)	-				
Rouwendal & Nijkamp(1984)					+
Schulze et al. (1981)					+
Sen (1961, 1967)				-	
Solow (1974)					+

Table 1. Aspects of time preference and multiple generations dealt with by different authors.

From all authors, Feldstein (1964) is the only one who does not reject 'pure' time preference (or 'irrational impatience') as a real phenomenon. Harrison (1981) can be regarded as a modern representative of Pigovian views on the dangers of a pure impatience. Surprisingly enough, Ramsey (1928) is a standard reference in the international literature, although he pays in his article only with one sentence attention to the phenomenon of time preference (qualified by him as 'ethically indefensible'). Kula (1985) is one of the few authors who incorporates the phenomenon of a limited lifetime as a real datum for fixing a social rate of discount in his analysis.

The fifth column of Table 1 indicates the fairly large number of authors who have explicitly paid attention to the importance of an intergenerational distribution of welfare, before a reasonable social rate of discount can be determined.

4. Opportunity Costs

It has been demonstrated in the previous section that in general the social rate of discount (reflecting the society's preferences regarding the intertemporal allocation of resources) is lower than the market rate of interest. Does this imply that in all cases the evaluation of public projects has to be based on this social rate of discount? To answer this question it is worth noting that the implementation of public projects requires the use of financial resources from the private sector. In many cases, the application of the market rate of interest yields for these resources in the private sector a higher rate of return than the social rate of discount would do. In general, private investments should have a rate of return which is at least equal to the gross market rate of interest (the usual market rate including the effects of taxation and subsidies). According to some authors (e.g., Hirschleifer, 1966) the government should therefore use the gross market rate of interest for the evaluation of public projects, as the use of the traditional social rate of discount (which is lower than the market rate) would lead to a transfer of scarce resources to less profitable projects. There appears to be a wide spectrum of views on this issue, and in the sequel of this section various standpoints will briefly be presented, followed again by a concise literature survey.

4.1. Pure opportunity costs

Advocates of the 'pure opportunity costs' viewpoint claim that financing public investments means that financial resources have to be transferred from the private to the public sector. However, such a transfer is only meaningful from an economic viewpoint, if the social rate of discount for public projects is equal to the marginal rate of return in the private sector (reflecting the pure opportunity costs).

This viewpoint does not necessarily hold in all cases, as the financial resources for public projects are usually not entirely paid by the private sector: they may also originate from the consumption sector. For the latter part the social rate of discount may be a reasonable evaluation criterion, although it has to be added that just the consumption sector is the ultimate main driving force for the high rate of return on capital investments (see Baumol, 1968). This crowding-out effect will be further discussed in subsection 4.2.

4.2. Crowding-out effects

The implementation of public projects implies crowding-out effects in both the consumption sector and the investment sector. According to Sandmo and Drèze (1971), the optimum rate of discount for public projects should therefore be a weighted average of the conventional social rate of discount (related to crowding-out effects for consumption) and the marginal rate of return on private capital (related to crowding-out

effects for investments). This - as such plausible - viewpoint involves however various difficulties, as the long-run effects of changes in consumption on the marginal rate of return on capital have to be assessed, while also the effects of shifts in investments have to be gauged. Furthermore, the re-investment possibilities and their long-run implications have to be considered (Marglin, 1963b). This re-investment problem will be further taken up in sub-section 4.3.

4.3. Crowding-out and re-investment effects

The implications of crowding-out and re-investment effects can be clarified as follows (see also Arrow, 1966, p. 20). Assume a project which requires in the initial base year one unit of investments, while next this project yields a fixed amount of revenues in all subsequent years (being a fixed percentage of the initial investment). The naive use of the social rate of discount (thus without considering the opportunity costs) would require that the abovementioned rate of return is at least equal to the social rate of discount.

However, the revenues accruing from the initial investment lead to an increase in both consumption and savings. Depending on the savings rate in an economy, the amount of investments and hence of future consumption may increase. Thus the net social value (or the shadow price) of the initial amount of investments is equal to the net present value of all extra consumption possibilities caused by this investment. This implies that public investments marked by crowding-out effects and re-investment possibilities have to be evaluated - in a situation of a steady economic growth - by means of the social rate of discount. Consequently, crowding-out effects of a public investment require that the resources transferred from the private sector be multiplied with the abovementioned shadow price. Analogously, re-investment effects (implying that the revenues of public investments flow back to the private sector) have to be multiplied with the same shadow price. The resulting costs and benefits can then be evaluated by means of the usual social rate of discount.

If the assumptions underlying the previous analysis (i.e., a fixed savings rate and a fixed marginal rate of return) are no longer satisfied, the latter conclusion does no longer hold (see Bradford, 1975, and Mendelsohn, 1981).

4.4. Second-best choices

In general, the problem of opportunity costs is caused by the second-best situation in which public investments are taking place. The reasons why public projects in stead of private projects are being carried out are not always unambiguous, while also various indirect effects of the transfer of financial resources may emerge. Consequently, it is sometimes argued (see Stiglitz, 1982) that one would have to examine which restriction

and disturbances are relevant for each project. General conclusions can hardly be inferred in that case, as the specific opportunity costs inherent in a certain public project preclude an unambiguous determination of the appropriate rate of discount for that project (which is then unequal to the social rate of discount, the marginal rate of return on capital or their weighted average).

4.5. Concluding remarks

The opportunity costs of public projects hamper a straight-forward assessment and use of a social rate of discount. The 'hunt for a solution in the dark jungles of the second best' (Baumol, 1968) has not been very promising so far. Nonetheless, a few interesting research directions can be identified. First, the opportunity costs can be incorporated in public project evaluation in two ways, viz. by adjusting the social rate of discount, or by calculating the shadow prices of public investments as the basis for a cost-benefit analysis. In the latter case, the social rate of discount may still be an appropriate candidate. Secondly, the various contributions to the use of the opportunity costs principle in public investment evaluation tend to show a convergence in that the attention is increasingly focused on project-specific elements of opportunity costs. This leads clearly to a greater flexibility in the analytical framework for judging the social relevance of public projects.

4.6. Compact literature survey

The previous findings will now briefly be summarized in a compact overview table. In contrast to Table 1, Table 2 includes mainly mutually excluding views.

authors	pure opportunity costs (subsection 4.1)	crowding-out effects (subsection 4.2)	crowding-out and re-investment effects (subsection 4.3)	second-best choices (subsection 4.4)
Arrow (1966)			+	
Baumol (1968)	(+)		(+)	
Bradford (1975)			(+)	+
Hirscheifer (1966)	+			
Kay (1972)			+	(+)
Marglin (1963)		+		
Mendelsohn (1981)				+
Stiglitz (1982)				+

Table 2. Aspects of opportunity costs dealt with by different authors.

Baumol (1968) appears to be a special case, as he points out the indeterminacy of the social rate of discount for public projects, although he seems to have a slight preference for the pure opportunity costs principle. Bradford (1975) and Kay (1972)

provide further reflections on Arrow's (1966) contribution. Kay tried to analyze less restrictive situations than implied by Arrow's analysis, and also Bradford attempted to show that Arrow's conclusion was applicable to a broader set of cases. Mendelsohn (1981) however demonstrated that the conclusions reached by Kay and Bradford were invalid. In a more recent article, Arrow (1982) has analyzed some variants on the model in his original article. He concluded that in some cases the marginal rate of return on capital could form an appropriate basis for the social rate of discount.

5. Risk Behaviour

Investment decisions in both the private and the public sector are always characterized by uncertainties (either in a systematic way or in an unstructured way). In the literature on risk analysis for public investments various views have been expressed on the treatment of risk elements, and these will briefly be discussed here.

5.1. Risk premium

The usual view on risk elements in investment behaviour is to add a special risk premium to the rate of return in order to cover unforeseen costs. This implies essentially that risky public projects have to be evaluated against a higher discount rate. This argumentation runs parallel to the observation that risky assets have to yield higher revenues on the capital market. One of the backgrounds of this phenomenon is that uncertainty reinforces the society's impatience, while it may also reduce the social value of the investment concerned. Uncertainty is to be regarded as an undesirable cost component, so that risky projects have to pass a higher threshold value in order to become acceptable.

A first problem in this context is of course the precise assessment of the risk. Next, the question may be raised whether a risk premium is always adequate. Clearly, in case of long-term uncertain benefits this may be an appropriate approach, but in case of long-term uncertain costs (e.g., the treatment costs of nuclear waste) a higher discount rate leads to an additional neglect of these disadvantages, as then (uncertain) future costs in the long run are regarded as less relevant.

5.2. Project-specific risks

In various cases, the uncertainties regarding the effects of an investment may have an impact on both the costs and the benefits, so that negative and positive elements have to be taken into consideration simultaneously. Furthermore, the uncertainties regarding costs and benefits may for a specific project exhibit a specific time trajectory so that the use of a uniform risk premium is inadequate. In order to compensate for such evolutionary effects, either the social rate of discount has to be adjusted (negatively or positively) over time for each individual project, or the resulting costs and benefits have to be re-assessed (see Nijkamp and Rouwendal, 1985).

5.3. External uncertainties

In addition to lack of insight into the effects (costs and benefits) of the project itself, in many cases one faces a situation where uncertain external developments (e.g., the growth trajectory of the economy as a whole) exert a significant impact on the judgement of the public investments. For instance, if a government is mainly interested in a stable and steady economic development, an investment which yields relative-

ly high revenues in a stagnating economy will be preferred to an investment with relatively low benefits in case of economic decline (see also Wilson, 1982). This implies that the risk correction for the social rate of discount is co-determined by the correlation between the costs or benefits of the project at hand and the development of the economy as a whole.

5.4. Risk differences

There is a large spectrum of public investment projects, and hence the risks inherent in the implementation of such a project are different. Due to the diversification of such risks the revenues of the whole set of risky projects can be predicted more precisely than those of individual projects (see also Samuelson, 1964 and Vickrey, 1964). Consequently, it is sometimes argued that there is no need to add an extra risk premium in the form of a mark-up percentage to public projects.

This argumentation takes for granted that the costs and benefits of the successive public projects are neither mutually correlated nor correlated with the general development of the economy. This is of course a rather stringent assumption which does not always hold true. Another drawback of this argumentation is that it assumes a pooling principle of public investments by one and the same government. This is usually not the case: there are different financial flows and different public agencies working in a pluriform government, so a uniform risk treatment in the public sector is an illusion.

5.5. Risk distribution

Another argument against the use of a risk premium in public investments is the fact that costs and benefits of such projects are directly or indirectly distributed over a large number of persons, so that for each person the risk is almost negligible (see Arrow and Lind, 1970). However, two remarks can be made in this respect. First, despite the 'large numbers' case of risk effects there is no guarantee that all risks are equally spread over all members of society, so that then a serious distributional problem may arise. And secondly, if the government does not correct its decisions for risk elements, this may imply that in the long-run too many projects are implemented which should not have been accepted in light of the actual risks involved. Such a situation will of course - in the long run - be detrimental for the economy as a whole. Finally, it should be added that the arguments of risk diversification and distribution hold also for large multinational companies.

5.6. Concluding remarks

The literature on risk analysis for public investment projects does not exhibit a concensus on the treatment of risk premiums. It is increasingly realized however, that

6. The Social Rate of Discount: Retrospect

In the previous sections, 3 main analytical lines have been distinguished for the determination and adjustment of the social rate of discount. The results of this survey do not lead to unambiguous guidelines for the evaluation of long-term public projects, a situation which was already characterized by Baumol as a'sorry spectacle' (Baumol, 1968, p. 788). Over a large number of years this debate has not led to more consensus, but - on the contrary - to more diversity in opinions (Lind, 1982, p. 10).

In the meantime the reasons for this divergence have become more clear: the key elements of the social rate of discount, viz. the social rate of time preference (co-determined by the views on the future economic development), the treatment of opportunity costs, and the treatment of risk and uncertainty, are controversial issues with a clear socio-economic and political content. It is worth noting in this context that often the problems of impact assessment, of monetary transformations into a common denominator, and of time preferences related to a discounting principle are intertwined.

A clarification of this discussion could probably be attained, if the original aim of the discount rate would be kept in mind. This aim is: to create a systematic comparision framework for cross-temporal financial flows related to alternative public investments. The social rate of discount has not been developed to take into account opportunity costs or risk elements. Only in a later stage of the discussion it was argued that the social rate of discount might be adjusted for such aspects. In our view, it is preferable to deal with the social rate of discount in its original pure form as the social rate of time preference.

Opportunity costs might then be taken into account via the abovementioned correction mechanism based on the assessment of shadow prices and the adjustment of costs and benefits accordingly. Risk elements might be included by assessing for the uncertain costs and benefits the certainty equivalence in each period, viz. the amount of compensation which has the same value for society as the set of uncertain costs and benefits.

Such approaches do not eliminate all problems inherent in risk elements and opportunity costs, but they lead to a more appropriate interpretation and use of the social rate of discount. The social rate of discount itself is still hard to assess, as it has to reflect the social rate of time preference. It is a plausible assumption that the social rate of discount is lower than the market rate of interest, but its precise value is still a source of rational speculation among economists. This also means that cost-benefit analysis is suffering from the same problems, although in many cases results from sensitivity analyses with regard the social rate of discount may provide - within certain limits - a reliable basis for public investment decisions. In the next section, some further reflections on the social rate of discount based on a welfare approach will be given.

7. The Social Rate of Discount: A Welfare-Theoretic Approach

Various authors have already advocated the use of a flexible social rate of discount, which should depend on the duration period of the project, the political concern for the next generation, and specific effects or features of the project at hand. In the present section, the issue of time preference will be further discussed by adopting a social welfare perspective for the planning of long-term public projects. It will be indicated that - under fairly general conditions - a variable discount rate is in agreement with a social welfare approach. Most of the arguments used in this section are based on Nijkamp and Rouwendal (1985).

One may assume a social welfare function W with income (or consumption) levels I_t $(t=1,\ldots,T)$ as arguments:

$$W = W(I_1 \ldots, I_T)$$

For project evaluation we have to determine the difference in welfare between the with and without situations:

$$\Delta W = W' - W^{o}$$

If the sign of ΔW is positive the execution of the project increases social welfare, if it is negative the project decreases welfare. If the effects of the project are relatively small we may approximate ΔW as:

$$\Delta W = \sum_{t=1}^{T} \frac{\partial W}{\partial I_t} \Delta I_t$$

In the equation ΔI_t is equal to the net benefits associated with the project in period t. It is thus equal to $B_t - C_t$ in our earlier formula (section 2).

Indeed one may now regard this equation as a welfare-theoretic formulation for the net present value equation in section 2. It can be derived that the implied rate of discount is determined by:

$$1+r_t = \frac{\partial W}{\partial I_{t-1}} \Big/ \frac{\partial W}{\partial I_t}$$

By adopting this welfare theoretic framework one may treat in a formal and explicit way the influence of income growth, additional care for future generations, and risk on the rate of discount. For details we refer to Nijkamp and Rouwendal (1985).

The social welfare approach is in our view a relevant one for discussing and analyzing the issues related to the rate of discount. Although it is usually stated that the net present value criterion cannot take into account the interests of the next generation, as the multi-temporal weights are declining over time and vanish in the end (cf. Myers, 1977), it can be shown by this type of analysis that, by adopting a variable rate of discount, this is certainly possible.

Similar conclusions may be reached for risk elements and externalities.

One conclusion that may be derived from this analysis is that the appropriate treatment of risk and opportunity costs very often necessitates a project-specific determination of the rate of discount. For policy-making it may be convenient to treat this project-specific concerns apart from the rate of discount. These project-specific concerns might then be dealt with in the determination of the cash-flows.

The specification of the appropriate rate of discount should in this view take place on the basis of more general considerations by which it is possible to assign the projects to a few broad classes (on the basis of risk, duration etc.) each with their own specific value of the rate of discount.

In this way the general aspects of time preference, risk, opportunity costs etc. are incorporated in the value of the rate of discount while the project-specific ones are dealt with by means of adjustments of the cash-flow estimates (e.g. by the use of shadow prices). By proceeding in this way it may be possible to take into account the insights gained from the theoretical reflections that can be found in the literature, while at the same time it remains possible to use general and feasible guidelines for project evaluation by means of discounting. Clearly, in case of intangible or incommensurable project effects, this approach is still fraught with difficulties, but the latter case complementary directions (e.g., multiple criteria analyses) have to be chosen.

Referenties

Arrow, K.J. (1966), Discounting and Public Investment Criteria, 13-32 in: Kneese, A.V. and Smith, S.L. (ed.) Water Research. J. Hopkins, Baltimore.

Arrow, K.J. (1982), The Rate of Discount on Public Investments with Imperfect Capital Markets. 115-136 in: Lind, R. (ed.), (1982).

Arrow, K.J. and Lind, R. (1970), Uncertainty and the Evaluation of Public Investment Decisions. American Economic Review, vol. 60, 364-478.

Baumol, W.J. (1968), On the Social Rate of Discount. American Economic Review, vol. 58, 788-802.

Blaug, M. (1978)(3), Economic Theory in Retrospect. Cambridge University Press, Cambridge.

Bradford, D. (1975), Constraints of Government Investment Opportunities and the Choice of Discount Rate. American Economic Review, vol. 65, 887-899.

Drèze, J.H. (1974), Discount Rates and Public Investment: A Postscritptum. Economica,vol. 41, 52-61.

Feldstein, M. (1964), The Social Time Preference Discount Rate in Cost-Benefit Analysis. Economic Journal, vol. 74, 360-370.

Grout, P. (1981), Social Welfare and Exhaustible Resources, Economics & Resources Policy (J.A. Butlin, ed.), Longman, London, pp. 88-109.

Harrison, R. (1981), Discounting the Future. Proceedings of the Aristotelean Society, vol. 82, 45-57.

Haveman, R.H. (1977), The Economic Evaluation of Long-Run Uncertainties, Futures, no. 9, pp. 365-374.

Heal, G.M. (1981), Economics and Resources, Economics & Resources Policy (J.A. Butlin, ed.), Longman, London, pp. 62-73.

Hirschleifer, J. (1966), Investment Decision under Uncertainty: Application of the State-Preference Approach. Quarterly Journal of Economics, vol. 80, 252-277.

Iwema, R. en Klaassen, L.H. (1981), Het Probleem van de Discontering. Economisch-Statistische Berichten, vol. 66, 1167-1170.

Kay, J.A. (1972), Social Discount Rates. Journal of Public Economics, vol. 1, 359-378.

Kirsch, G. (1984), Solidarity between Generations: Intergenerational Distribution Problem in Environmental and Resource Policy, gestencild.

Kula, E. (1985), An Empirical Investigation on the Social Time Preference Rate for the United Kingdom. Environment and Planning A, vol. 17, 199-212.

Lind, R. (ed.) (1982), Discounting for Time and Risk in Energy Policy. Resources for the Future, Washington.

Lind R. (1982a),A Primer on the Major Issues Relating to the Discount Rate for Evaluating National Energy Objects, 21-94 in: Lind R. (ed.) (1982).

Lind, R. (1982b), The Rate of Discount and the Application of Social Benefit Cost Analysis in the Context of Energy Policy Decisions, 443-458 in: Lind, R. (ed.) (1982).

Marglin, S. (1963a), The Social Rate of Discount and the Optimal Rate of Investment. Quarterly Journal of Economics, vol. 77, 94-111.

Marglin, S., (1963b), The Opportunity Costs of Public Investment. Quarterly Journal of Economics, vol. 77, 274-289.

Mendelsohn, R. (1981), The Choice of Discount Rates for Public Projects. American Economic Review, vol. 71, 239-241.

Mueller, D.(1974), IntergenerationalJustice and the Social Discount Rate. Theory and Decision, vol. 5, 263-273.

Myers, N. (1977), Discounting and Depletion, Futures, no. 9, pp. 502-509.

Nijkamp, P. and Rouwendal, J. (1985), The Social Rate of Discount in Project Evaluations: Implications of the Use of a Social Welfare Approach, Discussion Paper 85-15, International Institute for Environment and Society, Berlin.

Olson, M. and Bailey, M.J. (1981), Positive Time Preference. Journal of Political Economy, vol. 89, 1-25.

Pearce, D. (1983), Ethics, Irreversibility, Future Generations and the Social Rate of Discount. International Journal of Environmental Studies, vol. 21, 67-86.

Pigou, A.C. (1950) (4), The Economics of Welfare. MacMillan, London.

Ramsey, F.P. (1928), A Mathematical Theory of Saving. Economic Journal, vol. 38, 543-559.

Rawls, J. (1971), A Theory of Justice, Clarendon Press, Oxford.

Rouwendal, J. en Nijkamp, P. (1984), Netto Contante Waarde en Toekomstige Generatie Economisch-Statistische Berichten, vol. 69, 473-477.

Samuelson, P.A. (1964), Discussion. American Economic Review, vol. 54 (papers and proceedings), 93-96.

Sandmo, A. and Drèze, J.H. (1971), Discount Rate for Public Investment in Closed and Open Economies. Economica, vol. 38, 395-412.

Schulze, W.; Brootshire, D. and Sandler, T. (1981), The Social Rate of Discount for Nuclear Waste Storage: Economics of Ethics. Natural Resources Journal, vol. 21, 811-832.

Sen, A.K. (1961), Optimising the Rate of Saving. Economic Journal, vol. 71, 479-495.

Sen, A.K. (1967), Isolation, Insurance and the Optimal Rate of Discount. Quarterly Journal of Economics, vol. 81, 112-124.

Solow, R. (1974), Intergenerational Equity and Exhaustible Resources. Review of Economic Studies (Symposium), 29-45.

Stigler, G.J. and Becker, G.S. (1977), De Gustibus Non Est Disputandum. American Economic Review, vol. 67, 76-90.

Stiglitz, J.E. (1982), The Rate of Discount for Benefit - Cost Analysis and the Theory of the Second Best, 151-204 in Lind, R. (ed.)

Vickrey, W. (1964), Discussion. American Economic Review, vol. 54(papers and proceedings).

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