DISCOUNTING IN INTERGENERATIONAL PROJECT APPRAISAL – EFFICIENT VERSUS JUST DECISION MAKING

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Abstract

The problem of long term public investment appraisal, especially those affecting future generations is a complex issue consisting of the questions of the valuation of inputs and outputs, uncertainty and the problem of dealing with effects emerging in different moments of time. The last problem is usually solved by using discounting procedure.

The paper aims at analyzing the definition of the discount rate in project appraisal procedure in the light of effectiveness and justice of intergenerational investment decision making. The analysis includes answering the question of the rationale for discounting in short perspective in certain appraisal procedures concerning efficient and just decision criteria. Then, selected ethical approaches to future generations' rights are presented as the basis for establishing the connection between the discount rate and intergenerational justice. Finally, various levels of discount rate are analyzed assuming different rights assignment to present and future generations.

Keywords: public investment, investment project appraisal, discount rate
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1. INTRODUCTION

The discount rate is one of the crucial elements in any project appraisal procedure. The procedure of discounting reflects the opportunities that are lost because of involving resources in the planned investments. Any small changes in the level of the rate affect substantially the present value of the investment and influence the decision to implement or reject the project, especially in case of very long term effects opposing immediate expenditures. The rise of the discount rate from 1% to 2% reduces present value of 1 000 000 obtained after 100 years by almost 63% (from 369 711 to 138 033).

The question of what exact level of discount rate should be chosen is therefore vital for the outcome of the long term project analysis. The issue is complicated additionally by various assumptions considering decision criteria that can be applied for appraisal procedure. While in the short perspective, where all costs and benefits accrue to the investor, the effectiveness criterion is sufficient and discount rate is a necessary measure of forgone investment opportunities, when the time span extends to other generations, the definition of
discount rate changes significantly. The rate becomes the reflection of future generations importance at the moment when the investment decision is being taken.

2. DECISION CRITERIA IN THE INVESTMENT APPRAISAL PROCESS

Discounting in the short perspective reflects the diminishing value of future effects. Discount rate should display the cost of forgone opportunities to ensure that the postponement of consumption is justified. The future effects are calculated in terms of present value and compared to investments outlays borne at the beginning of the investment process [Boardman et al., 2001, 126-129]. When benefits of the project exceed its costs – the project is accepted, otherwise – rejected.

Present value is calculated with use of some discount rate, although the method of defining the level of the rate differs depending on the type of appraisal method and decision criteria. Those rules define also the way of calculating the inputs and outputs of the project.

The criteria in investment decision-making process can be defined as:
1. criterion of financial efficiency – are the outputs obtained commensurate to the inputs when both are measured in market prices?
2. criterion of economic efficiency – are the outputs obtained commensurate to the inputs when both are measured in efficiency prices?
3. criterion of justice – whether the allocation of project effects maximizes wellbeing of the society.

2.1. CRITERION OF FINANCIAL EFFICIENCY

The criterion can be formulated in the following way:

\[
FNPV = \sum_{t=0}^{n} \frac{FCF_t}{(1+r_m)^t} \rightarrow \max
\]

\(FNPV\) – financial net present value of the investment,
\(FCF_t\) – financial cash flow in year \(t\),
\(r_m\) – market rate of discount,
\(t\) – time period \((t = 0,1,2,\ldots, n)\) where \(n\) is the last year of project life in the analysis.

The project is accepted if \(FNPV\) equals zero or is positive. \(FCF_t\) are the expression of project effects: inputs (investment outlays) and outputs (investment gains) calculated on the basis of market prices. The rate \(r_m\) is also calculated from the data available on the market to reflect the opportunity cost for the investor. The outcome of the analysis measures the change (increase if \(FNPV \geq 0\)) of the owner’s assets financial worth.

The financial efficiency criterion is relevant when a purely private project is evaluated. All the inputs and outputs of the project should be then traded on the efficient markets, so the project will not generate any external effect, change public goods, etc. Assuming the financial markets are efficient, the use of market discount rate will lead to the achievement of maximum increase in the wellbeing of the investor. Although, where some failures on the markets emerge, the private perspective is insufficient and other criteria would give different results.
2.2. CRITERION OF ECONOMIC EFFICIENCY

Economic criterion can be denoted as:

\[ \text{ENPV} = \sum_{t=0}^{\infty} \frac{EFC_t}{(1 + r_e)^t} \rightarrow \max \]  \hspace{1cm} (2)

\( \text{ENPV} \) – economic net present value of the investment,
\( EFC_t \) – economic cash flow in year \( t \),
\( r_e \) – economic rate of discount (social rate of discount).

The project is accepted if \( \text{ENPV} \) equals zero or is positive. \( EFC_t \) is the reflection of project effects; however they are calculated with use of efficiency prices (shadow prices, economic prices) that are prices cleared off market distortions. The rate \( r_e \) is also calculated as a shadow price of capital to reflect the opportunity cost or time preferences of the society. The outcome of the analysis measures the change (increase if \( \text{ENPV} \geq 0 \)) of the economic assets worth for society and takes into account all project impacts, both market and non-market.

The economic criterion is usually applied when a public project is analysed. The private perspective is not sufficient here as some of the project impacts are off-market or their market prices don’t reflects true social preferences as well as opportunity cost of resources.

There are several methods like Cost-Benefit Analysis, Cost-Effectiveness Analysis, etc., which are based on the calculation of economic cash flows that are estimated with the use of efficiency prices that aim at correcting market failures and reflect opportunity costs and true social preferences.

The rationale of defining the discount rate is similar as its level should be in agreement with social preferences towards trading present for future. The concepts of calculating SDR differ significantly in the literature. The most widely accepted are:

- SDR as an opportunity cost of capital – to reflect opportunities lost by society when the evaluated project is accepted, the rate is estimated on the basis of rates of return of the rejected investments;
- SDR as a consumption rate of interest – based on social preferences towards deferring consumption in exchange for future profits [EPA, 2000, 39];
- mixture of the above [Spash, Hanley, 1994, 131].

2.3. CRITERION OF JUSTICE

Justice criterion offers a solution that suppose to maximize social welfare based on just social allocations. Sometimes the criterion is named utility criterion [EVALSED, 2009, 41]. Those can be equivalent on the assumption that seeking for maximizing social welfare must satisfy at the same time social idea of justice. The welfare function can be denoted as: \( W(U) = W(U_1, U_2, \ldots, U_m) \)  \hspace{1cm} (3)

\( U_i \) – utility of \( i \) individual or group \( i \) \( (i = 1, 2, \ldots, m) \).

However the utility criterion can be further divided into:

- intragenerational justice – is the allocation of project costs and benefits just within one (present) generation?
- intergenerational justice – is the allocation of project costs and benefits just between all members of generations affected by the project? The second type refers in fact to sustainability, however defined in the wider, social context. The most common
interpretation of sustainability is that development policies should be constrained so as to leave stocks of natural resources at their original level [Quiggin, 1997, 65-90]. As EVALSED defines: “The criterion of sustainability is also linked to the concept of sustainable development which can itself be regarded as one definition of utility, particularly if sustainable development is defined as concerning the maintenance of human, productive, natural and social capitals rather than just the maintenance of the environment for future generations” [EVALSED, 2009, 43].

To begin with, short perspective should be discussed first. The formula for project appraisal according to the utility criterion can be denoted as:

$$ SNPV = \sum_{i} \sum_{t} w_i ECF_{it} \cdot \frac{1}{(1 + r)^t} \rightarrow \max $$

$SNPV$ – social net present value of the investment,
$ECF_{it}$ – economic cash flow in year $t$ for individual (group) $i$,
$w_i$ – weight for an individual’s (group’s) $i$ economic cash flow.

Social net present value is calculated as a weighted sum of discounted economic cash flows. Maximization of $SNPV$ means maximization of social welfare within one generation. The differences in utility between individuals or groups are reflected by the weights for $ECF$ that depend on which group welfare the $ECF$ change. The weights are the reflection of weights of individuals’ utility in the social welfare function.

The equation above concerns short perspective (within-generational), where the use of social discount rate is justified by the opportunities that the contemporary society loose deciding to invest in the project and is similar to the definition in the economic efficiency criterion. That brings those two criteria very close, except for differences in economic cash flow allocation.

The justice criterion is applied mostly to some public investment projects or programmes. The use of justice criterion should prevent situations where the project costs are incurred more often by some groups, while benefits would apply mostly to the others [Stiglitz, 1994, 117-118].

However, when the utility criterion is used for longer time perspective, the definition of the criterion itself as well as of the discount rate changes. That is explained later on in the paper (paragraph 3).

Worth mentioning is also the change in distinction between public and private investments. The private and public projects in the intergenerational context should be treated in the same way on the assumption that as the time span extends, the effects that accrue only the individual investor disappear. In the long perspective the range of affected parties is significantly broadened, so the individual efficiency measurement is not sufficient any more. Taking into account few generations makes in fact any project public, although not in static but in dynamic sense.

All the above criteria differ in the outcome of the analysis as well as in the definition of the applied discount rate. Financial efficiency postulate using market discount rate that serves as a measure of opportunity cost of capital for the investor. Economic and utility criteria use social discount rate that is the reflection of opportunities that are lost for the society. It’s worth to underline that for those two in the intragenerational context, the discount rate is defined in the same way. The need for achieving efficiency in utility allocation is guaranteed by the weights for economic cash flow.
3. THE JUSTICE AND FUTURE GENERATIONS – DEFINING THE ETHICAL CRITERIA

Introducing moral criteria into the investment appraisal is based on the assumption that evaluating intergenerational effects involves inevitably accepting some ethical approach towards future generations. As future persons have not been born yet, all the valuation and decisions are taken by the contemporary people. This “future ethic” defines present generation as responsible for future generations [Birnbacher, 2006, 23-24]. Other words – present generation ethical approach towards next generations defines the character and scope of investment decisions involving long term effects.

The main issue here is the question about the assignment of rights to future people that reflects their importance in the eyes of today individuals. Main ethical approaches in that field can be divided into the following: utilitarian, libertarian, egalitarian, elitist and naturalist [Spash, 2002, 223-226]. They are presented on the fig.1:

![Figure no. 1 Rights of future and present generations under various ethical rules](image)

*Source: based on [Foltyn-Zarychta, 2010 (forthcoming)]*

The range of rights given to future and contemporary people vary from full to no assignment. The approaches are described below.

3.1. PRESENT GENERATION POSSESS NO RIGHT

The approach is rather theoretical assumption for maintaining the analysis complex. The consequences of accepting such ethical rule would mean abandoning all projects that bring benefits to present generation on the expense of the future. Deferring the consumption for infinite period of time would be preferred above any other decision. Strict observance of the rule would lead to determining the minimum level of present population consumption that is necessary for surviving;

3.2. PRESENT GENERATION POSSESS SOME RIGHTS BUT LESS THAN FUTURE GENERATIONS

The ethical rule treats future effects as more important if they apply to future generations. The approach have its roots in deep ecology ethics (naturalist), that assumes the rights
should be assigned not only to humans, but also to other creatures (animals or plants) and in case of long term investments – to future generations [Perman 2003, 57-58].

The approach concentrates mostly on environmental resources that are on the brink of extinction (plants, animals) or non-renewable resources (fossil fuels). The worth of such goods suppose to rise over time and investment outlays today, if they do not exploit resources like mentioned above, should be easily balanced by future effects. The ecosystem or natural capital, as well as future generations, possess the value for themselves [Light, 2005, 4].

**3.3. FUTURE AND PRESENT GENERATIONS POSSESS EQUAL RIGHTS**

Equal assignment of rights is proposed by two approaches: egalitarian and libertarian based on Pareto efficiency rule.

Egalitarian ethics postulates equal treatment of all generations. It is based on Rawls’ intergenerational rule of justice that arouse from the criticism of utilitarianism. It states that allocations are fair if they are accepted by everyone and are the consequences of impartial and rational decision [Dierksmeier, 2006, 72-83]. To guarantee fair choice the individuals (generations) are put in the starting point behind “a veil of ignorance”, which means they don’t know what will be their position after the change [Wolf, 2005, 8-9]. It leads to the agreement on two fundamental principles of justice: 1) each person is to have an equal right to the most extensive basic liberty compatible with a similar liberty for others; 2) social and economic inequalities are to be arranged so that they are both reasonably expected to be everyone’s advantage, and attached to positions and offices and open to all – inequalities are only justified if they lead to Pareto improvement (“The Difference Principle”) [Rawls, 2009, 62-65]. The outcome of such decision is minimization of negative effects – the level of welfare is determined by the position of the least wealthy (satisfied) generation.

Pareto rule is classified among libertarian approaches, however it also strives to equalize the position of all affected groups. The basic ethical rule in libertarian approach is that human individual rights are inviolable; there are no other rights than of human individuals and behaviour is assessed in terms of whether or not it respects those rights. [Perman et al., 2003, 58-61]. Allocations are just if they are entirely consequences of free choices [Connelly, Smith, 1999, 9-15]. Pareto rule specifies that the intergenerational transfers are acceptable if no generation will find itself in worse position after the change than it was before [Hausman, McPherson, 2009, 136-140]. If any effect of the project is adverse, the decrease in welfare should be compensated or the project should be abandoned if the compensation is impossible. If we assume that the original position is the state of contemporary generation, then the rights of future people are as important as of the today’s (no worse than).

**3.4. FUTURE GENERATIONS POSSESS SOME RIGHTS BUT LESS THAN PRESENT GENERATION**

The approaches that give more weight to present than future are based on libertarianism and utilitarianism. They are part of humanist philosophies, where rights and duties are accorded exclusively to human beings (either as individuals or as communities) [Perman et al., 2003, 59-60].
The first is based here on Kaldor-Hicks criterion (K-H), which adapts all Pareto assumptions except for one: compensations for changes in welfare are only potential here, whereas in Pareto approach they are necessary [Zerbe, Bellas 2006, 12-13]. Then the rights of the future generations are not guaranteed on the original level – next generations can find themselves poorer if the contemporary gain is overwhelmed by the future loss. The only criterion is that the overall sum of welfare gains and losses should be positive if the project is to be accepted. Such assumptions, when only present generation decide, may lead to accepting projects that bring more benefits to the present than to the future without any intention to compensate possible loses in future wellbeing.

The second approach is neo-classical utilitarianism that defines just allocation as the allocation that leads to the maximization of the sum (weighted sum) of all generations utility [Perman et al., 2003, 59-61]. The allocation have to satisfy the needs of the consumer, who decides which actions are good (utility enhancing) or bad (utility diminishing) for her or his well-being [Hausman, McPherson, 2009, 99-104]. The decision is justified if the marginal utility of present generation payment is lower than the marginal utility of benefits of the future generation – then the summarized welfare increases. Future generations can possess rights, however only as a part of welfare function of the present generation where their rights are usually explained by the effects of altruistic or bequest motives.

3.5. FUTURE GENERATIONS POSSESS NO RIGHT

Under this ethical rule future generations are regarded as unimportant by today individuals. It is based on the elitist approach, which postulates that only the wellbeing of the elite generation is maximized. All projects that increase the utility of the elite are justified. The elite is defined as the present generation that have the full range of rights to make the decisions. The planning horizon is equal to the life time of the elite, which means that the future effects are simply omitted in the analysis. Future generations have their chance to be regarded in the decision only if their rights inclusion will increase the welfare of the present (derive pleasure from the benefits for future people, similarly to the utilitarianism – as the effect of i.e. altruism).

The issue of future generations rights defining lies more in the field of ethics that economics. It means that any economic decision considering intergenerational effects is taken on the basis of some ethical concept that define those rights. The discount rate becomes here the issue of central interest as its level influences present value of the effects accruing to future generations.

4. AN ATTEMPT TO DEFINE THE DISCOUNT RATE LEVEL UNDER SELECTED ETHICAL APPROACHES

In the intergenerational context a social rate of time preference is used as a term for discount rate. In example Green Book defines it as a rate used for discounting future benefits and costs, based on comparisons of utility across different points in time or different generations [HM Treasury, 2003, 97]. It reflects weighty ethical issues concerning how the present treats future generations [Hepburn, 2006, 5].

To answer some of the above dilemmas the concept of intergenerational theory of justice is proposed. The intergenerational theory of justice is a basis that explains the nature and the content of our duties (if they exist) towards future generations, that are defined as
people that haven’t been born yet [Wolf, 2005, 1-2]. The major question is then to make a decision considering the welfare allocation between present and future. The concepts presented in the previous section form the basis for formulating the weights for generations in the intergenerational welfare function and estimating the intergenerational discount rate level.

The intergenerational welfare function can be denoted as:

$$IW(U_T) = IW(U_1, U_2, \ldots, U_p)$$  \hspace{1cm} (5)

$$U_T$$ – utility of generation $$T$$, ($$T=0,1,2,\ldots, p$$).

The appraisal criterion for the intergenerational investment project based on equations 1, 2 and 4 can be denoted in the following form:

$$INPV = \sum_{T=0}^{p} SNPV_T = \sum_{T=0}^{p} \lambda_T SNPV_T$$  \hspace{1cm} (6)

$$INPV$$ – intergenerational net present value of the investment,

$$SNPV_T$$ – social net present value of the investment for generation $$T$$,

$$r_T$$ – intergenerational rate of discount,

$$\lambda_T$$ – weight for generation $$T$$, discount factor $$\lambda_T = \frac{1}{(1+r_T)^T}$$.

The discount rate can be denoted as a discount factor that in fact reflect the importance and rights of each generation. Discount rates are constituted on the basis of weights of generations in intergenerational welfare function. The weight of the generation depends on the accepted philosophical approach – it becomes a function of ethical rule that shapes the stand of the decision-maker/society. However the weight of the present generation is always 1, as the T starts from 0.

![Figure no. 2 The weight of future generation and the level of the discount rate under selected ethical approaches](image)

On the basis of ethical concepts presented in the previous section the discount rate can take various levels. To simplify the analysis assume there are only two generation, present, denoted as $$T=0$$, and future, denoted as $$T=1$$.

Assuming, as above, that the weight of the present equals 1, the Figure 2 presents the levels of discount rate and weights of future generation under selected ethical approaches.
4.1. PRESENT GENERATION HAVE NO RIGHTS

The weight of present generation in the calculation of the value of the project aims at zero while the weight of the future aims at infinity. The discount rate aims at minus infinity. The consequences of applying the above level of the discount rate are that any project impacts for contemporary generation, not matter if they are good or wrong, are not important if only they can guarantee the increase in future wellbeing. That would lead to accepting projects irrespective of today’s outlays if only they generate some minimal amount of future positive impacts. The discounted value of present costs aims at zero while any future benefits aims at infinity.

4.2. PRESENT GENERATION POSSESS LESS RIGHTS THAN FUTURE – DEEP ECOLOGY

The discount factor that serves as a weight of the present is here smaller than the weight of the future generation. The discount rate is negative to reflect the higher value of the future effects. The present generation possess some rights but is considered less important than the future – any today’s project outlays are worth less than the future effects assuming the same nominal value. Applying negative discount rate leads to accepting a project benefiting primarily for future generation but present effects also count. The exact balance between present and future depends on how low is the discount rate – the lower it gets, the less worthy are the present inputs in comparison with future outputs.

4.3. ALL GENERATIONS HAVE EQUAL RIGHTS – EGALITARIANISM, PARETO RULE

To satisfy the condition of equal rights the weights of all generations must be equalized. The simplest method is to apply weight of unity to all parties. That makes discount rate equal to zero. Then all projects effects, not matter what generation they impact, will be equal to their nominal value for each generation in calculating project intergenerational present value. No preference is given to future or present. However, the rationale for zero discount rate differs slightly between both approaches. Under the egalitarian rule the assumption for applying zero discount rate is the minimax strategy where the increase in the overall welfare is possible when the least wealthy generation gains; if in the decision-making point no-one knows which generation welfare will be improved as a consequence of implementing the project, the only option is to treat all as equal, so the decision-makers won’t find themselves in the worse position after the change.

On the other hand, the Pareto rule assumes that the project will leave the initial level of utility or improve it. If the diminishing the welfare is forbidden, all generation must have equal weights. Otherwise it would lead to unfair decisions. The proposed level of a discount rate under this rule should be zero, although some suggest using positive rate of discount [Spash, Hanley, 1994, 135-139, Pearce, Barbier, 2000, 241-244].
4.4. FUTURE POSSESS LESS RIGHTS THAN PRESENT GENERATION – UTILITARIANISM, KALDOR-HICKS RULE

The weight of the future generation is smaller than that of the contemporary generation. The discount rate is positive here. The consequence of implementing such a rate is that any future effects are valued less than their future nominal value, which is explained by the fact that future generation is less important.

Under the utilitarianistic approach future is given less weight because the effects won’t apply to people living at present and they are deferred in time while the individual prefers immediate effects. The future is important to the extent in which it increases present generation utility. Similarly, according to Kaldor-Hicks criterion, individuals have the inviolable bundle of rights and the power to decide. However, contrary to Pareto rule, the compensation for any negative project change is only potential. Any adverse effect doesn’t have to be compensated as long as the overall sum of impacts is positive, so it’s possible for decision-maker to apply here positive discount rate and not be obliged to compensate for it.

The exact level of the discount rate depends on individual preferences, leading to maximizing utility or guaranteeing free choice. No specific details can be given here except the fact that the discount rate shouldn’t be higher than the market rate, that represents short-term preferences, where people treat future on purely effectiveness ground. The lower the level of the rate below market rate the more importance is given to future people.

4.5. FUTURE HAS NO RIGHTS – ELITISTS APPROACH

The weight of the future aims at zero while the weight of the present aims as infinity. The discount rate here aims at infinity. The lower margin of the discount rate is the market level. The approach can be interpreted as purely myopic. As under the elitist rule all rights are applied to present generation, the future effects are omitted in the analysis. The project becomes intragenerational and immediate, short term effects are preferred.

Practical applications of the above levels of the discount rates are obviously restricted. The usual approach of the decision-makers is based on the utilitarian approach [Pervan et al., 2003, 351-253]. Social time preference rate is used to reflect society preferences toward future effects. The positive discount rate is justified on the assumptions that humanity may become extinct in the future, risk involved in future consequences, diminishing marginal utility for future generations which should be richer that today’s and perfect substitution of all resources [Pervan et al., 2003, 73]. The controversy arise also around positive pure time preference rate, which some authors find irrational in long term analysis [Yu, 2006, 144-161].

On the other hand there are many examples of the elitists approach, where future is regarded completely unimportant – there are usually developing projects (mines, dams, etc.) placed in some natural areas where the decision is based solely on the immediate effects for the owner. The higher the discount rate, the short-term projects are more preferable.

It is worth emphasising that some authors rise doubts also about applying the same discount rate to all goods, including health, climate change or forestry [Hepburn 2007, 5-13]. The value of long term discount rates varies also significantly between countries. The level of the real discount rate vary from 1 (Czech Republic) to 10 per cent (Australia, Canada). Most popular are values ranging from 4 to 6%. Some countries, like UK or France, adopt time declining discount rates [Hepburn 2007, 25-31].
4. CONCLUSIONS

The problem of appraisal of intergenerational investment is a complex issue. The financial or economic effectiveness as well as intragenerational justice criteria are insufficient for long-term projects affecting unborn generations. Accepting market level of the discount rate or searching for some social discount rate based on contemporary data on opportunity cost of capital or consumption rate of interest will only reflect the interests of the present generation, where future impacts can be of slight importance.

The necessity to widen the decision criteria emerges from the impossibility to include the rights of future generations directly as they are not capable of disclosing their preferences. Then some moral approach must be applied today to define their rights on the basis on intergenerational justice rule.

The approaches vary from no right assignment for the present, through giving less importance (deep ecology), equal rights (egalitarian and Pareto rules) and more importance to the present (utilitarian and Kaldor-Hicks approaches), to applying no right to the future generations (elitists approach).

The defined ethical rules have a significant impact on the outcome of the analysis as they establish the levels of the discount rates on the basis of the weights given to the present and future people. The rate, according to the adapted approach, starts from minus infinity, for the rule excluding rights of the present, reaches 0 for equal rights assignment and then aims at plus infinity when all rights are given to the present. Intermediate cases, where future or present people are treated as more important, generate some, respectively, negative and positive levels of the discount rate, however the exact value depends on the generation’s level of importance or unimportance. The more distant from zero the value is, the difference in rights assignment is more substantial.

The appraisal of the long-term investment project depends heavily of the level of the discount rate applied. However, except for the question of fairness in right assignment for the contemporary and the following generations, there are other issues that need to be dealt with, like the valuation of future inputs and outputs and the uncertainty in environment of conditions that are about to change substantially over such long period of time.

References

The criterion in theory is based on Pareto efficiency; however, in practice Kaldor-Hicks criterion is applied. An allocation of resources is efficient in Pareto sense if it’s not possible to make anyone better off without making at least one other person worse off. To achieve Pareto efficient allocation 3 conditions must be fulfilled: 1. efficiency in consumption, when marginal rates of utility substitutions are equalized among individuals, 2. efficiency in production, when marginal rates of technical substitution between resources are equalized among produced goods, 3. product-mix efficiency, when marginal rate of transformation between goods is equal to marginal rate of utility substitution for that goods [Perman et al. 2003, pp. 107-109]. If additionally market prices reflect this dependence, the economy achieves Pareto efficient state and efficiency prices are not needed to be calculated.

Most of public projects are projects that affect public goods that suffer from market failures. However, even if project effects are private, the use of public resources will involve some external effects and social perspective should be taken into account.

There are different forms of W. The most popular is the formula where weights of individual utilities in the function are calculated in the basis of marginal utility of consumption for different groups.

The simplifying assumption is applied here that the just allocation is already satisfied within each generation. Preference-based utilitarianism is criticized by raising the question whether individuals’ preferences lead to choices that are always good for people and if the preferences reflect their true interests. There can be situations where due to i.e. information bias or advertising bias the choices are not necessarily optimal. Second issue highlighted is the difference between choices made by the consumer and citizen, where in the citizen position some additional criteria may be taken into account or the time perspective can be consciously stretched to next generations.
Intergenerational rate of discount, as formulated here, is similar to the utility discount rate, as the SNPV is the reflection of the change of utility for each generation [Compare: Hepburn 2007, p. 19].

7 In well functioning democracy the views of the decision-maker should be in agreement with the view of the society that chooses the leaders. That is why society and decision-maker can be treated as synonyms.