Discounting in intergenerational investment appraisal - Survey results

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Appraising projects with intergenerational effects is a complex task, incorporating the issue of bringing future impacts to present value. This is usually achieved by applying the discount factor. However, the choice of discount rate to intergenerational context faces multiple technical and moral problems. The paper analyses a theoretical rationale behind the concept of intergenerational discount rate and preliminary assessment of intergenerational discount rate level in Poland based on survey done in 2012 among Finance & Insurance Faculty students at University of Economics in Katowice showing the decline in the value of discount rates with time.

Introduction

The problem of taking a rational investment decision in case of project with intergenerational effects involved is a quite complex issue, incorporating various research questions: starting from identification and estimation of future intergenerational impacts and uncertainty of effects in the long run and finishing with the choice of appraisal method (i.e. financial analysis, cost benefit analysis, multicriteria assessment). The last but not least is the issue of estimating the present value of future impacts to compare them with contemporary investment inputs. In financial analysis it is achieved by applying the discount factor that serves as a weight of future investment outputs and allows comparison of effects appearing in different moments of time.

The higher discount rate (r) is and the more remote in time the effects are (higher t), the lower discount factor and present value of any future investment outcome are. When the time perspective is getting longer, the influence of the level of the discount rate becomes a crucial variable for calculating investment effect. To illustrate this, let us take 1 000 000 of investment effect that appears after 300 years. Its present value (PV) is a little less than 50 000 when the discount rate equals only 1%.

However, if the discount rate would be doubled, to 2% (which is still much lower than the usual market discount rates) the present value of the effect drops to about 2 500, which is 20 times less than PV for 1%. Figure 1 illustrate the pace of PV diminishing as time frame stretches from 1 year to 300 years. In the above context, of tremendous importance is estimating the value of the discount rate as a crucial variable for the final investment decision when long term effects are involved.

Nevertheless, applying the concept of financial discount rate may be insufficient here as it does not incorporate any trace of intergenerational perspective. The fact that the present

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generation makes decisions affecting future of the people not yet born, will raise a need to define the relationship between the level of the discount rate and the attitude of people living now to the future generations.

FIGURE 1. PRESENT VALUE OF THE INVESTMENT EFFECT WORTH 1 MILLION AT DISCOUNTS RATES EQUAL 1% AND 2% FOR TIME PERIOD OF 1, 10, 100 AND 300 YEARS
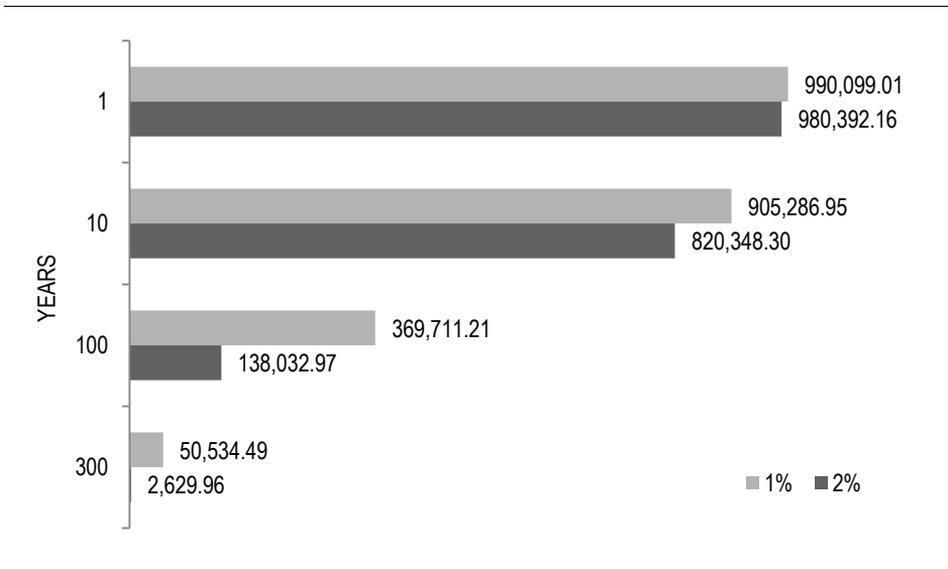
Source: Own study

The paper aims at calculating a preliminary value of intergenerational discount rate for Poland based on individual preferences. The analysis strives for verifying two hypotheses:

H1. Discount rate declines as the effects become more remote in time.

H2. Discount rate is lower for effects excluding the respondent and his descendants.

The research presents a theoretical rationale behind the concept of intergenerational discount rate based on a short literature review and a preliminary assessment of intergenerational discount rate level based on survey results done in 2012 among Finance & Insurance Faculty students at University of Economics in Katowice.

The concept of intergenerational discount rate

Reviewing international scientific achievements in the field of intergenerational project appraisal, the issue must be considered as a continuation of research, where the bottom line is the concept of social discount rate combined with theories of economic growth, including sustainability issues (e.g., Baumol, 1968; Weitzman, 2001; Malaga, 2011).

The literature concerning empirical examples of eliciting the intergenerational discount rate is quite vast, including i.e. research papers estimating the social discount rates (Evans, Sezer, 2005) and researches in eliciting intergenerational discount rates, including the concept hyperbolic discounting (Cropper et al., 1991; Henderson Bateman, 1995). Surveys used for observing people intertemporal preferences are designed in various ways. Some researches construct the study as laboratory experiments, using dichotomous choice question, payment card or rating questions (Frederick, 2003). The considerable portion of

studies refer to saving lives programs, where dichotomous choice questions are used, where respondents are asked to choose one of two projects, where one has its effects delayed in time (Chapman, 2001). Those researches use the number of lives (not the value of life) and the discount rate is calculated on the basis of comparison of present and future number of lives saved done by an individual- respondent.

The results of researches estimating intergenerational discount rate suggest that the rate diminish as the effects becomes more remote in time and the direction of change is negative (the rate is declining over time), however the values differ in particular studies. For instance OXERA (2002) report proposes to use for periods up to 30 years the rate equal to 3.5% and - as the time frame increases - to reduce the value to 2% for effects delayed by 125 to 200 years, and further, to 1% for effects appearing after more than 300 years. Weitzman calculates that for immediate future (1-5 years) the discount rate equals 4%, and then drops by 1 pp.respectively: for near future (6 to 25 years), medium future (26 to 75), distant future (76-300), and then reaches 0% for far distant future (more than 300 years) (Weitzman, 2001).

Polish studies in the subject are scarce: intergenerational discount rate issue is analysed in the context of changes in the level of discount rate depending on the ethical concept (Foltyn-Zarychta, 2010) or as the advantages and disadvantages of some concepts of intergenerational discount rate implementation (Berbeka, 2008).

Survey design

The survey was conducted among of 1st year MA students at University of Economics in Katowice in June 2012. A total of 238 questionnaires were collected, of which 211 were subjected to further analysis, while 27 questionnaires were rejected due to incompleteness.

The questionnaire consisted of three parts:

a. Introductory questions - exploring the attitude toward future generations
b. The valuation of future investment results, as the basis for calculating the intergenerational discount rate
c. Socio-economic characteristics of the respondent.

The valuation questions were closed format questions with 12 different numbers of lives saved and the ability to answer "do not know", which was supplemented by an open-ended question. This differs from the format of the questions most frequently used in the literature (dichotomous choice), but is justified by several factors:

- Respondents were students of Faculty of Finance and Insurance. It can be assumed that they should be more competent to answer questions related to the intertemporal valuation.

- The survey was a preliminary study, aimed at questions formulation validity and it was limited in the number of respondents.

Protest bids were eliminated from discount rate valuation. There were two types of protest bids distinguished in the survey results: respondents selecting "0" number or "all" of lives saved for the delayed effects. It should be noted that these responses should be considered rare, meaning that their elimination, in addition to methodological reasons, should not have a significant impact on the results obtained. For data processing MS Excel and IBM SPSS Statistics software was used.

Estimating the intergenerational rate of return

In the valuation section respondents were asked to compare the effects of projects that save lives. Valuation was based on a comparison of two projects with equal outlays.

Project A generates the effects of saving 100 lives immediately, while project B will rescue some number of people (multiple choice), but with a certain time lag. The task was to select a minimum number of people project B should rescue to offset the immediate lost of project A effects. Another words, respondents had to decide how many lives saved in the future will be enough to accept 100 lives lost today. In addition project B effects are becoming more distant in time in consecutive questions (by 5, 25, 75 and 300 years). Respondents were also asked about two types of project B effects: including and excluding lives of respondents themselves or their descendants.

It is assumed that when the respondent select one of the options he or she is indifferent to the choice between A or B - both projects are equally desirable. This means that immediate effects of the project A are equivalent to the delayed project B effects. This allows estimating the value of the discount rate for life-saving effects.

In order to estimate the discount rate the following formula was used, assuming continuous compounding:

$$PV_{EA} = FV_{EB}e^{tr_t} ,$$ (1)

Where,

PV_{EA} - immediate effects of project A (present value);

FV_{EB} - delayed effects of project B (future value);

t - the delay of effects;

r_t - rate of return for specified delay.

In the literature, there are basically no references to the method of capitalization, however implicitly annual capitalization is involved. As far as the financial effects are considered, it is reasonable to adopt simplifying assumptions, according to which cash flows occur at the end of each year and are capitalized on an annual basis. Nevertheless, it is worth considering that the effect of human life saving could be estimated under a continuous compounding assumption. The calculations are therefore following continuous compounding assumption, although changing the capitalization frequency do not affect testing the hypotheses as the continuous time rates are simply a little bit lower than usual annual compounding.

TABLE 1. CALCULATION OF DISCOUNT RATE FOR VARIOUS DELAYS

| Life saving projects	Years			
	5	25	75	300
mean				
including heirs	17,3%	19,4%	9,6%	8,2%
excluding heirs	16,3%	18,1%	9,1%	7,7%
median				
including heirs	13,9%	15,6%	10,1%	10,0%
excluding heirs	8,1%	15,6%	10,1%	10,0%
mode				
including heirs	32,2%	30,4%	15,1%	15,0%
excluding heirs	32,2%	30,4%	15,1%	15,0%
Source: Own study				

The results obtained indicate that with increasing time distance the average rate of return (at which the value of current and future effects are equal) shows a general downward trend. For five-year delay logarithmic rate for projects affecting the respondent and his descendants was 17.3%. It should be noted here that for 25 years the rate rose slightly - to 19.4%, which is the direction opposite to the working hypothesis. However for longer delays, that is, 75 and 300 years, this rate behaves as expected, reaching values, respectively: 9.6 % and 8.2%. Results of the calculations are presented in Table 1.

Higher rate for 25-year delay may be explained by the fact that respondents perceive the effects as affecting them directly, the same way as for the first, 5-year delay, however being substantially delayed in time. Comparing the two delays, the respondents demanded a higher rate for effects that can save their lives with a greater delay, so with risk being much higher. This result, inconsistent with expectations, may therefore lead to the conclusion of developing the concept of two separate discount rates: intergenerational (that would be decreasing in time) and intragenerational (that could be stable or increasing).

The results indicate also that the average value of discount rate for life-saving projects, where the respondent and his descendants are affected, is - on average - higher than the discount rate for projects saving the lives of people strange to the respondent. The rate of return for projects not involving the respondent and his heirs may be also considered declining (except, as previously 25-year delay option). For 5-year period the rate was 16.3%, for 25 years: 18.1%. Then, for 75 years it drops to 9.1%, and for 300-year delay: to 7.7%. This lower value of rate for projects not affecting the respondent (and his descendants) means that if project B is about to save some number of strangers, the number of live saved is - on average - smaller than in case of project was aimed at saving the respondent himself or his family. An important observation is that the lower discount rate refers to all delay options: both the immediate future (5-year) and the effects remote in time. The difference between the rates for the two types of projects (including and excluding heirs) ranged from 1.26 pp.(for the highest rate for 25-year period), to about 0.5 pp (for delays of 75 and 300 years). For the nearest future, this difference was 1 percentage point (Figure 2). According to Chapman (2001) the rate for longer period can be lower because the decisions are made on behalf of others. The same reason is found here, where comparing projects including heirs and excluding them from project effects.

FIGURE 2. THE DIFFERENCE BETWEEN DISCOUNT RATE FOR PROJECTS INCLUDING AND EXCLUDING THE RESPONDENT AND THE HEIRS
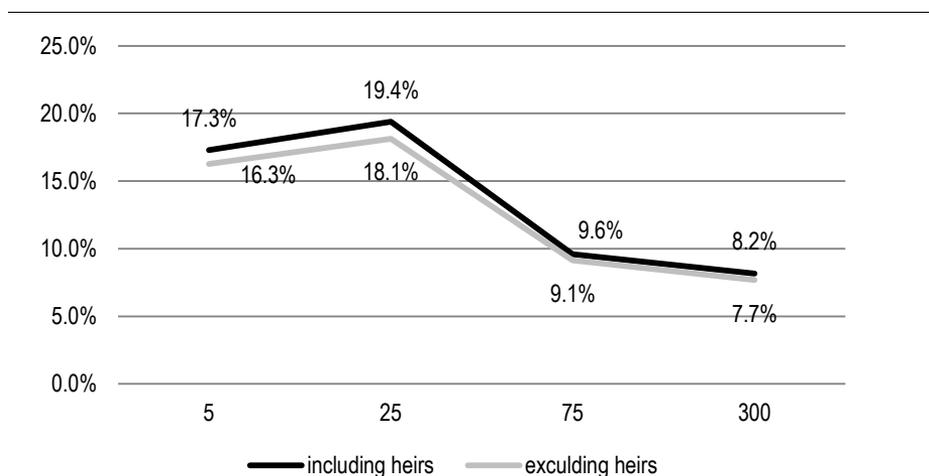
Source: Own study

Analysing the distribution of results (Table 2), it must be concluded that the standard deviation values decrease as the length of the time horizon increases for both: the project affecting the respondent and his heirs and excluding him or his descendants. In a similar manner the values of coefficient of variation behave: for a five-year period CV has a value in excess of 110%, for 25 years for both kinds of projects it varies in the range of 80-90%. However, for periods exceeding the life time of the current generation, the relation of SD to mean stays in the range 60-70%.

TABLE 2. VARIABILITY AND ASYMMETRY OF DISCOUNT RATE DISTRIBUTIONS

Years	5	25	75	300
SD				
including heirs	19.72%	17.37%	5.59%	5.16%
excluding heirs	20.34%	14.99%	5.67%	5.23%
CV				
including heirs	114.13%	89.63%	58.29%	63.24%
excluding heirs	125.03%	82.72%	62.08%	68.15%
As				
including heirs	-0.76	-0.63	-0.98	-1.32
excluding heirs	-0.78	-0.82	-1.04	-1.40

Source: Own study

It can be assumed that declining (with time) variability of the results is probably caused by the lack of a reference point for such long periods of analysis. The high variability (CV>100%) for the 5-year period can be attributed, first, to higher level of comprehension (lower numbers of life saved, which were presented to the respondents), the second - more knowledge of the issues and the ability to compare with situations in reality. It is worth noting that only in case of 5-year delay more than one respondent indicated the number of lives saved to be less than 100. A five-year period is also possible to compare with financial decisions and financial rates of return faced by the respondents in the market.

In the end, negative skewness can be observed. In all questions the comparison of the mean, mode and median values shows that $\bar{x} < Me < Mo$ which means that the majority of respondents declared rate of return higher than the mean. In addition, the middle respondent declared the rate higher than average, but lower than the mode. The coefficient of skewness for each question took negative values.

Conclusion

The discount rate calculated on the basis of survey results varies from 17.3% for 5-year delay to 8.2% for 300-year delay for projects saving lives of respondents and her of his future heirs and reaches values from 16.3 to 7.7% respectively for projects saving people strange to the respondent. Due to perceived inconsistencies about 25-year delay, it should be noted that it is impossible to unambiguously confirm the veracity of the first hypothesis H1: "Discount rate declines as the effects become more remote in time".

Turning to second hypothesis, H2: "Discount rate is lower for effects excluding the respondent and his descendants", in the light of the results, it can be confirmed. Discount rate calculated for projects affecting the respondent and his descendants is higher than the rate calculated for the projects excluding both, irrespectively of the period of effects delay.

The calculation of the discount rate for effects estimated in units (lives saved), not money terms, should be treated as an intermediate step to the final estimation of the project present value. First, future lives saved are brought to present equivalents by applying the

discount rate, and then they can be measured in money as the value of a statistical life (VSL), and finally included into the calculation of the net present value of the project.

Leaving future lives as physical units instead of money values allows in some cases to avoid calculating the value of life, which is an area triggering a lot of controversy. The disadvantage of this approach is that it does not let automatic integration of estimated values into the economic evaluation of the project (i.e. ENPV in CBA). However, it may be sufficient if the task involves comparison of several life-saving projects with equal expenditures, or in cases when cost-effectiveness ratios are calculated. What is important here is that it allows skipping the controversial part of human life valuation (which often gives results that differ substantially of the valuation stage of human life). It should also be mentioned that the concept of discounting the physical effects of investments is not new, as it appears in cost effectiveness analysis or dynamic generation cost indicators (e.g., Boardman et al., 2001; Rączka, 2002; Miłaszewski, 1999).

The basic justification for raising the issue of intergenerational discount rate is the tremendous sensitivity of future effects for the level of the discount rate. The issue of discount rate becoming a crucial variable (as the time frame extents) must be of special interest in appraisal of investments generating impacts on future generations. The fact that the present generation makes decisions affecting the future of the people not yet born, is also a landmark raising a need to define the relationship between the level of the discount rate and the attitude of people living now to the future generations.

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