DIFFERENCES IN INTERTEMPORAL PREFERENCES FOR MONEY AND ENVIRONMENTAL GOODS: THE CASE OF POLAND

Rafał BUŁA

University of Economics in Katowice, Faculty of Finance, Department of Investment;
rafal.bula@ue.katowice.pl, ORCID: 0000-0002-9890-7078

Purpose: The main scientific purpose of the paper is twofold. At first, the author aims to determine whether there exist any significant differences between intertemporal preferences of Polish citizens for money and environmental goods as measured by elicited individual discount rates. Additionally, the purpose of the paper is to reveal the socio-economic and demographic factors influencing the abovementioned intertemporal preferences.

Design/methodology/approach: The data about individual intertemporal preferences and socio-economic and demographic characteristics were collected via an online survey. To determine the respondents' willingness to pay and their individual discount rates the stated approach was used – the conditional valuation (CV) method. In the analysis of statistical properties of data collected various statistical methods were used. The differences between estimated discount rates were investigated by employing ANOVA methods, while the influence of socio-economic and demographic factors on their level was assessed by building and estimating a multiple regression model.

Findings: The main outcome of the paper is proving that the individual discount rates decline when the time frame considered is lengthened. At the same time, it has been revealed, that there exist significant differences between elicited discount rates for various types of goods analyzed – the lowest one for public environmental goods, while the highest one for private monetary benefits.

Research limitations/implications: One of the limitations of the study is the disadvantage of the Multiple Price List method employed resulting in a limited number of possible discount rates elicited. Even though the respondents could have given any other value they wished, this possibility was rarely used.

Practical and social implications: The estimated individual discount rates for various types of goods provide information about societal preferences regarding intertemporal choices. The outcomes of the study can be used to evaluate the efficiency of public policies regarding environmental protection, energy transformation, etc.

Originality/value: The studies analyzing the level of individual discount rates for various types of goods (especially environmental ones) in the case of Poland are quite rare and of limited number of respondents involved. In this study not only their levels for different goods (monetary vs environmental, private vs public) are compared, but also factors influencing them are considered and revealed. Moreover, while analyzing the willingness to pay for the abovementioned types of goods, the fact that the respondent is an inhabitant of the GZM

Metropolis or not is also considered to provide information about differences in intertemporal preferences between the residents of mining regions and others.

Keywords: intertemporal preferences; discount rate; money; environmental goods; mining regions.

Category of the paper: research paper.

1. Introduction

One of the most important challenges nowadays, as described by the Sustainable Development Goals of the United Nations, is taking action to combat climate change and its consequences while ensuring affordable, reliable, sustainable and modern energy for all (United Nations, 2015). All these efforts require additional investments transforming economies into green and circular ones. Among the countries facing significant challenges in this field is Poland. Despite the efforts to diminish the level of greenhouse gas emissions over past years (Bórawski et al., 2022) (Figure 1) and share of fossil fuels in electricity generation, total energy supply (Figure 2) and total final production (still the highest one among all members of the International Energy Agency in 2020) (International Energy Agency, 2022), the challenges posed by the European Green Deal and Fit for 55 plan focused on EU's target of reducing net greenhouse gas emissions by at least 55% by 2030 are quite demanding.
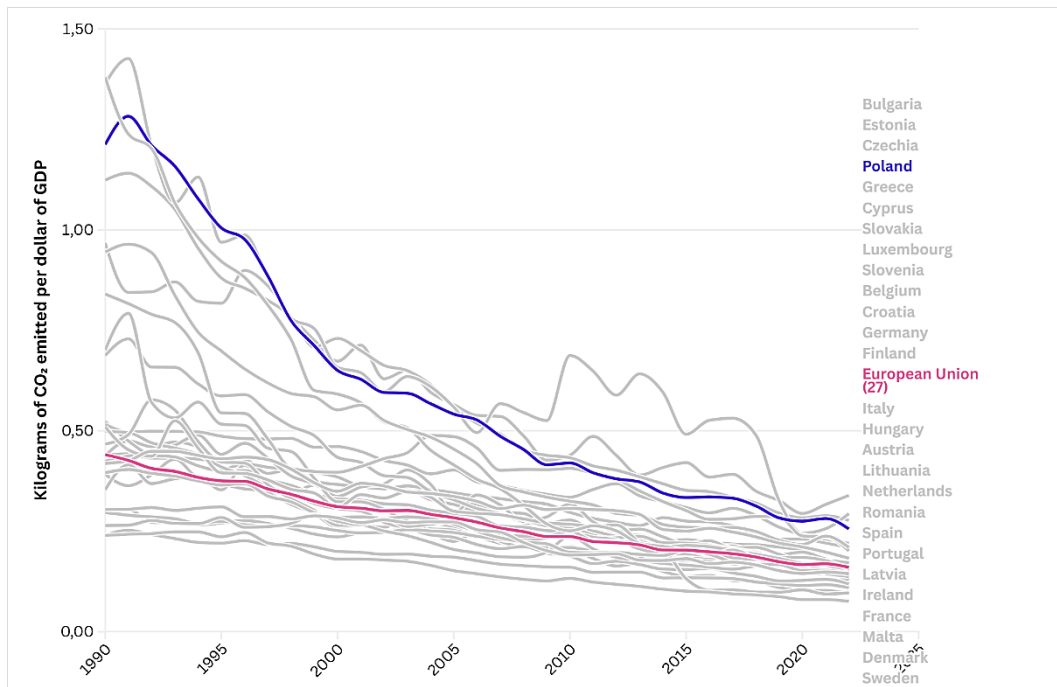

Figure 1. CO$_2$ emissions per GDP (in USD).

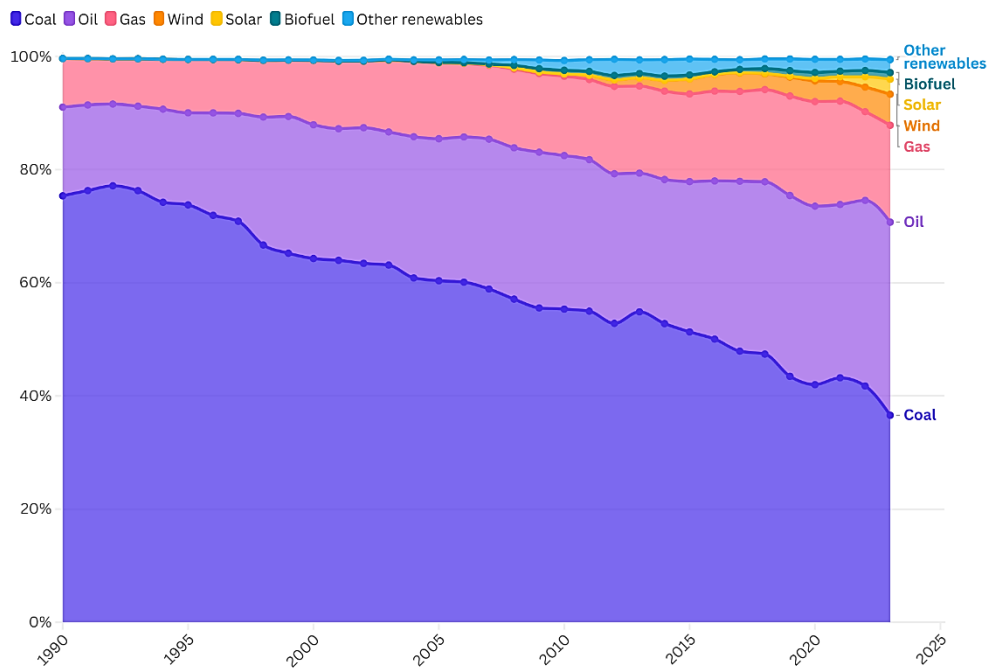Source: Own elaboration based on (Our World in Data, 2024).

Figure 2. Evolution of the total energy supply structure for Poland.

Source: Own elaboration based on (Our World in Data, 2024).

A crucial parameter in making decisions to invest due to different time profiles of costs and benefits is the discount rate. Taking into account the high sensitivity of the outcomes of the investment project evaluation to changes in the discount rate, it can be observed that it plays a crucial role in making decisions related to energy transformation, as these decisions have long-term impacts. As not all the costs and benefits can be easily measured in monetary terms due to non-marketability, a widely used method is the so-called contingent valuation (CV), an approach based on the stated preferences of the respondents regarding their willingness to pay for future changes in the consumption level of a specific good. Nevertheless, it is not an easy task to determine its pattern (e.g. constant vs declining) and level. The main aim of this study is to determine the level of individual discount rates for three types of goods: private monetary benefits, public monetary benefits and public environmental benefits. The hypothesis regarding their level can be formulated as follows:

H1: The discount rate for private monetary benefits is the highest one, while the discount rate for public environmental goods is the lowest one.

Moreover, as proved by many studies, e.g. (Buła, Foltyn-Zarychta, 2022) the level of discount rate should not be taken as constant, but due to variability in consumption patterns or divergence of the opinions of society members, should decline over time. Thus, the second hypothesis claims, that:

H2: The discount rates for all types of goods considered decline with lengthening of the time horizon considered.

In the next section the methods used to verify the abovementioned hypotheses as well as the material are described.

2. Material and methods

Elicitation of individual discount rates can be based on data gathered in various ways, e.g. online surveys, natural experiments, etc. To obtain a sufficiently large and, at the same time, representative dataset an online survey was conducted. The questionnaire prepared was distributed within one month (1-31 August 2024) by a professional company among adult inhabitants of the Republic of Poland and, consequently, 2000 responses were collected. To make the data collected representative the quota sampling method was employed. As a result, the analyzed dataset is representative if the place of living (voivodship), gender and age are considered.

The questionnaire was divided into a few parts. In the first one, the respondents were informed about the aim of the survey (analysis of attitudes towards environmental protection) and asked to share their opinions. In the next part, they were asked about basic demographic attributes as well as socio-economic status (gender, age, education level, number of household members, having children below 18 years of age, place of living including county and voivodship). In the following one, the participants were confronted with three hypothetical situations. In the first one, they were informed about winning 100 PLN in a lottery (private monetary benefit). The main assumption describing the second one was that the Ministry of Climate and Environment receives an additional amount of money (100 m PLN) to increase the area of national parks in Poland and enable more citizens to visit them without altering the biosphere (public monetary benefit). In the third scenario, they were informed that Białowieża National Park's area is going to be increased by 100 ha (public environmental benefit). Then, the respondents were asked a contingent valuation question, formulated as "What reward in the future would induce you to resign from the immediate reward of 100?" (separately in all three scenarios). Among different options used to reveal the respondents' willingness to pay, the Matrix Multiple Price List of (Richards, Green, 2015) was applied (the MMPL employed is presented in Table 1).

Table 1.

Matrix Multiple Price List used in the survey

Payment							
Imme-diately	After 1 year	After 5 years	After 10 years	After 30 years	After 50 years	After 70 years	After 100 years
100	100	100	100	100	100	100	100
100	101	104	105	108	108	109	111
100	102	108	110	116	116	119	122
100	105	120	128	145	145	155	165
100	110	144	163	210	210	238	270
100	115	170	206	302	304	368	444
100	125	236	324	615	630	860	1 180
100	140	372	620	1 740	1 840	3 040	5 050
100	160	640	1 380	6 600	7 450	15 800	34 000
100	180	1 050	2 900	23 800	29 000	79 000	220 000
100	200	1 640	5 750	81 000	108 000	380 000	1 380 000
100	other	other	other	other	other	other	other

Source: Own elaboration.

One of the problems encountered while asking the contingent valuation question is the lack of trust expressed by the respondents. Simply since they do not believe that the experimenter will remit payment at a future date (the "front-end-delay effect"), they heavily prefer short periods as within a short period the payment seems to be more probable. To avoid this obstacle, the respondents were informed that all the payments would be delayed by one month due to bureaucratic requirements to be fulfilled, following the idea of (Andersen et al., 2008).

In the next part of the questionnaire respondents' attitudes towards environmental protection as well as their values, beliefs and norms are measured using the NEP and the Value-Belief-Norm model scales (Dunlap, Van Liere, 1978; Stern, 2000; Stern et al., 1999). Moreover, the participants' trust in public authorities at different levels (local, municipal, state) is measured as well as their knowledge about national parks and environmental protection in Poland.

The last section of the survey is devoted to the investigation of economic issues, i.e. level of net income, loans, savings and perceived creditworthiness of respondents. It is aimed at measuring the socio-economic status of participants, like in the first part various demographic characteristics were included.

The socio-economic and demographic profile of the respondents is presented in Table 2. The dataset is representative while taking into account place of living (voivodship), gender and age. The geographical distribution of respondents is shown in Figure 3.

Table 2.
Demographic and socio-economic profile of respondents

Variable	Options	Share - survey	Share - Poland
Gender	Female	52.25%	51.64%
	Male	47.75%	48.31%
Age	18-29	14.95%	15.23%
	30-39	18.00%	17.96%
	40-49	19.85%	19.52%
	50-59	15.05%	14.96%
	60 and more	32.15%	32.33%
Education	Primary school	1.05%	5.70%
	Vocational school	9.45%	
	Middle school	0.60%	
	High school	31.05%	56.4%
	Post-secondary school	11.70%	
	Bachelor's degree	9.35%	37.9%
	Master's degree or higher	36.80%	
Household size	1	14.40%	22.57%
	2	29.70%	25.06%
	3	26.60%	19.04%
	4	19.50%	16.33%
	5	6.25%	17.01%
	6	2.50%	
	7	0.75%	
	8 and more	0.30%	
Children under 18	Yes	36.00%	37.55%
	No	64.00%	62.45%
Living place	Rural	26.60%	40.55%
	Urban	73.40%	59.45%
Net income (monthly)	Up to 1500 PLN	5.35%	-
	1501-3000 PLN	15.75%	
	3001-4500 PLN	29.25%	
	4501-6000 PLN	22.65%	
	6001-7500 PLN	9.80%	
	7501 PLN and more	7.90%	
	Do not want to answer	9.30%	
Credit/loan	Yes	27.05%	47.90%
	No	72.95%	52.10%
Savings/investments	Yes	47.35%	55.00%
	No	52.65%	45.00%
Creditworthiness (declared)	Yes	60.30%	-
	No	39.70%	

Data for Poland as of 2023 except for household size and children under 18 (Census 2021), credit/loan and savings/investment (2024).

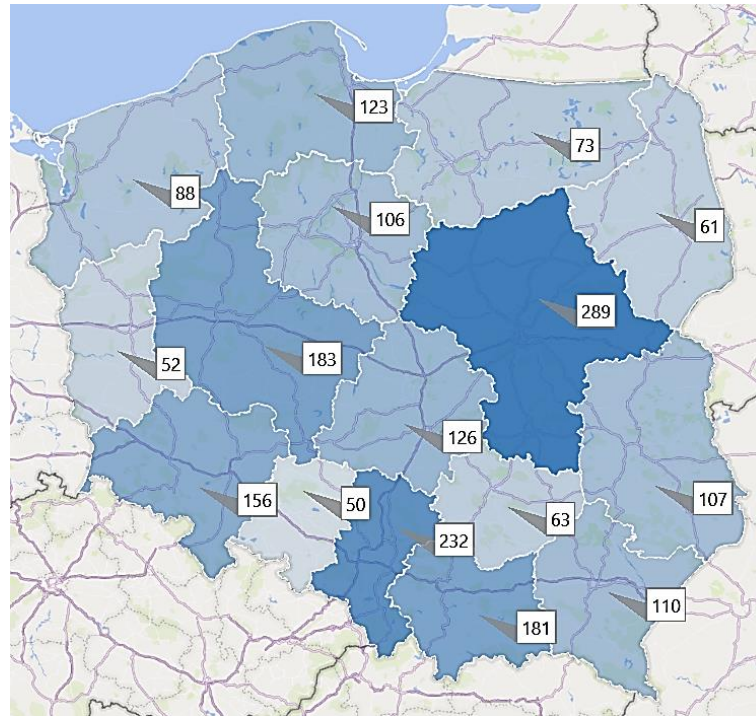Source: Own elaboration and (Bankier.pl, 2024; BIK, 2024; GUS, 2023).

Figure 3. Number of respondents from each voivodship.

Source: Own elaboration.

The demographic and socio-economic profile of the respondents is quite similar to the entire Polish society with some discrepancies regarding education level, living place (rural vs urban) and financial situation. However, the abovementioned differences do not seem to be severely influencing the conclusions presented in the following sections.

As the respondents were not asked directly about their discount rate, but rather their willingness to pay, the individual discount rates were calculated (as logarithmic ones):

$$R = \frac{1}{n} \ln \left(\frac{WTP}{100} \right) \tag{1}$$

where:

n – time horizon in years,

$n = 1, 5, 10, 30, 50, 70, 100$,

WTP – declared compensation required. This transformation performs better than if the discount rate is calculated as an average, simple required rate of return or even the geometric one, reducing the number of outliers (the Grubbs' statistic decreases significantly).

In this paper two methods of statistical analysis were used: the standard multiple regression model and the ANOVA method. The analysis of variance was used to predetermine the possible influence of single factors on the level of elicited individual discount rates and to verify the hypothesis that discount rates are equal for different goods and various time horizons. The influence of demographic and socio-economic factors on the level of individual discount rates was investigated by estimating a linear multiple regression model for every type of good and compensation delay:

$$R = \beta_0 + \beta_1 \cdot Gender + \beta_2 \cdot Age + \beta_3 \cdot Education + \beta_4 \cdot Household\ size +$$
$$+\ \beta_5 \cdot Children\ under\ 18 + \beta_6 \cdot Living\ place + \beta_7 \cdot GZM\ Metropolis +$$
$$+\ \beta_8 \cdot Net\ income + \beta_9 \cdot Credit|Loan + \beta_{10} \cdot Savings|investment +$$
$$+\ \beta_{11} \cdot Creditworthiness + \xi \tag{2}$$

where the variables: Gender (male – 0, female – 1), Education (high school or lower – 0, post-secondary school or higher – 1), Children under 18 (no – 0, yes – 1), Living place (rural – 0, urban – 1), GZM Metropolis (if a respondent is not an inhabitant of GZM Metropolis – 0, otherwise – 1), Credit/loan (no – 0, yes – 1), Savings/investment (no – 0, yes – 1), Creditworthiness (no – 0, yes – 1) are binary variables.

The ANOVA analysis was conducted as an analysis of a series of repeated measurements, as the respondents were asked about the level of their willingness to pay for a wide variety of time horizons and types of goods. As the final check, the post hoc Bonferroni test was used to compare the differences between measurements. The results are delineated in the next section.

3. Results and discussion

In the first step, the level of elicited discount rates (Figure 4) was compared and tested using the ANOVA method. The detailed statistical description of elicited discount rates is presented in Table 3.
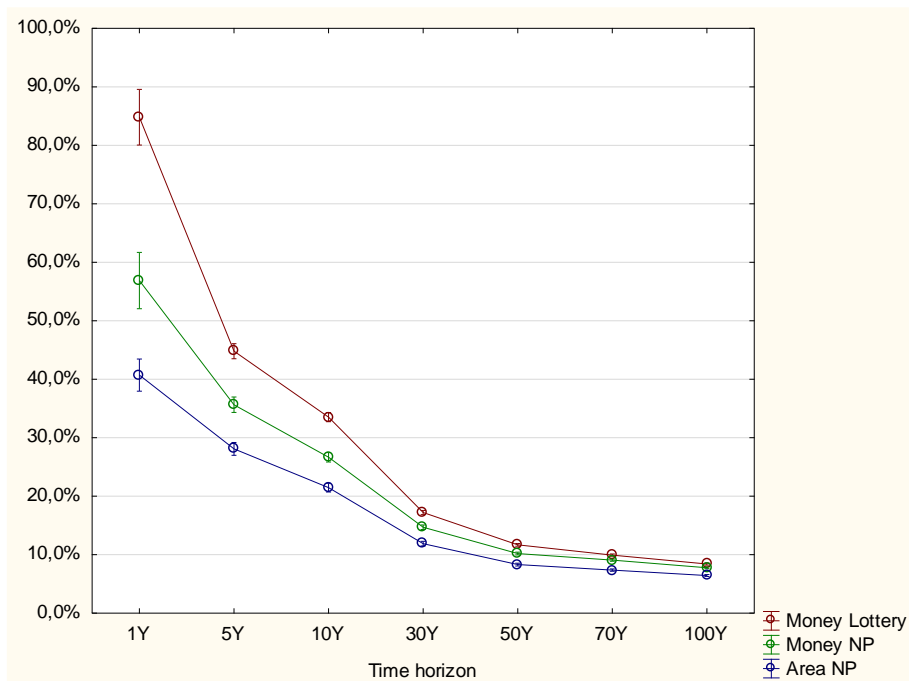

Figure 4. The averages of elicited discount rates with errors.

Source: Own elaboration.

Table 3.
Statistical characteristics of the elicited individual discount rates

Type of good & delay	Average ± Error	Median	Mode	Min	Max	St. dev.	CV
Money lottery 1Y	84.8% ± 2.4%	69.3%	69.3%	0.0%	990.3%	108.5%	127,9
Money lottery 5Y	44.8% ± 0.7%	47.0%	55.9%	0.0%	216.4%	29.3%	65,3
Money lottery 10Y	33.5% ± 0.4%	40.5%	40.5%	0.0%	115.1%	17.8%	53,1
Money lottery 30Y	17.2% ± 0.2%	19.0%	22.3%	0.0%	61.4%	8.1%	47,3
Money lottery 50Y	11.7% ± 0.1%	14.0%	14.0%	0.0%	46.1%	5.3%	45,1
Money lottery 70Y	9.9% ± 0.1%	11.8%	11.8%	0.0%	42.8%	4.4%	44,8
Money lottery 100Y	8.4% ± 0.1%	9.5%	9.5%	0.0%	115.1%	4.5%	53,1
Money NP 1Y	56.9% ± 2.5%	58.8%	69.3%	0.0%	1450.9%	109.8%	193,0
Money NP 5Y	35.6% ± 0.7%	37.1%	55.9%	0.0%	322.4%	30.2%	84,6
Money NP 10Y	26.7% ± 0.4%	26.2%	40.5%	0.0%	177.3%	18.4%	69,0
Money NP 30Y	14.7% ± 0.2%	18.2%	22.3%	0.0%	62.0%	8.9%	60,3
Money NP 50Y	10.2% ± 0.1%	11.3%	14.0%	0.0%	41.4%	5.4%	52,7
Money NP 70Y	9.1% ± 0.1%	11.8%	11.8%	0.0%	49.3%	4.4%	48,5
Money NP 100Y	7.8% ± 0.1%	9.5%	9.5%	0.0%	39.1%	3.6%	46,1
Area NP 1Y	40.7% ± 1.4%	33.6%	69.3%	0.0%	1371.0%	62.8%	154,2
Area NP 5Y	28.1% ± 0.6%	26.3%	55.9%	0.0%	274.2%	25.0%	89,0
Area NP 10Y	21.5% ± 0.4%	18.2%	40.5%	0.0%	207.2%	17.1%	79,6
Area NP 30Y	11.9% ± 0.2%	9.5%	22.3%	0.0%	92.1%	8.9%	75,0
Area NP 50Y	8.3% ± 0.1%	8.6%	14.0%	0.0%	64.5%	5.5%	66,6
Area NP 70Y	7.4% ± 0.1%	9.5%	11.8%	0.0%	52.6%	4.6%	62,7
Area NP 100Y	6.4% ± 0.1%	7.7%	9.5%	0.0%	41.4%	3.7%	58,3

NP – National Park.

Source: Own elaboration.

The first conclusion to be drawn upon the abovementioned results is the fact the level of elicited discount rates is steadily decreasing (at a slower pace, but that seems to be quite natural as the compensation to be declared is bounded from below, and as a result, the discount rates cannot be negative). The remarkable differences in the averages and low standard errors suggest the existence of statistically significant differences between elicited discount rates. The hypothesis that they are equal across various time horizons and types of goods was tested using the ANOVA method (repeated measures as the declared willingness to pay values were declared by the same respondents) and the post-hoc Bonferroni test to investigate which particular differences are significantly different. The results of the analysis are presented in Table 4.

Table 4.
The results of the ANOVA analysis (repeated measures) and Bonferroni posthoc test for the elicited individual discount rates

Time horizon	1Y		5Y		10Y		30Y		50Y		70Y		100Y
Money Lottery	84.8%	>	44.8%	>	33.5%	>	17.2%	>	11.7%	~	9.9%	~	8.4%
	∨		∨		∨		∨		∨		∨		∨
Money NP	56.9%	>	35.6%	>	26.7%	>	14.7%	>	10.2%	~	9.1%	~	7.8%
	∨		∨		∨		∨		∨		∨		∨
Area NP	40.7%	>	28.1%	>	21.5%	>	11.9%	>	8.3%	~	7.4%	~	6.4%

NP – National Park.

Source: Own elaboration.

The results of the ANOVA analysis with the post-hoc Bonferroni test confirm the main earlier predictions. The differences between discount rates for time horizons from 1 year up to 50 years show significant variability of the elicited discount rates and their diminishing character. This supports the hypothesis that lengthening the time horizon should lead to the application of the concept of the declining discount rate, DDR (Gollier, Weitzman, 2010; Lowe, 2008; Weitzman, 1998, 2001). This study provides a clear confirmation that the DDR concept can be applied to various types of goods, including environmental ones. This trend is maintained even when the time horizons over 50 years are considered, but due to variability of the elicited discount rates the Bonferroni test does not allow to reject the hypothesis of their equality.

Performing a similar analysis but now considering the type of good as the main interfering factor provides a clear justification for the assumption that the level of discount rate applied should be different for distinct goods. The elicited discount rates are unequivocally lowest for the enlargement of the national parks (public environmental good) and highest for private monetary benefits. This relationship is valid for all time horizons considered.

To analyze the influence of the demographic and socio-economic factors on implied discount rates, a multiple regression analysis was performed. The results are summarized in Tables 5-7.

Table 5.
The results of multiple regression for private monetary benefits

Delay	1Y	5Y	10Y	30Y	50Y	70Y	100Y
Intercept	1.1363	0.5417	0.3970	0.1887	0.1236	0.1028	0.0882
Gender	0.1803	0.0429	0.0250	0.0077	0.0025	0.0010	- 0.0009
Age	- 0.0081	- 0.0030	- 0.0019	- 0.0007	- 0.0004	- 0.0002	- 0.0003
Education	0.1247	0.0498	0.0315	0.0146	0.0083	0.0068	0.0041
Household size	- 0.0684	- 0.0129	- 0.0079	- 0.0025	- 0.0020	- 0.0016	0.0003
Children (under 18)	0.0594	- 0.0076	- 0.0088	- 0.0014	0.0015	0.0014	- 0.0021
Living place	0.0711	0.0072	0.0046	0.0022	0.0021	0.0009	0.0037
GZM Metropolis	- 0.0920	0.0181	0.0121	0.0027	- 0.0000	0.0007	0.0011
Net income	- 0.0624	- 0.0003	0.0015	0.0042	0.0022	0.0029	0.0003
Credit/Loan	0.1166	0.0308	0.0184	0.0063	0.0024	0.0019	- 0.0006
Savings/investment	- 0.0170	0.0008	- 0.0042	0.0006	0.0023	0.0023	0.0014
Creditworthiness	0.0303	0.0164	0.0183	0.0085	0.0072	0.0060	0.0030
R^2	0.0313	0.0395	0.0433	0.0348	0.0301	0.0265	0.0129
Adjusted R^2	0.0253	0.0337	0.0375	0.0290	0.0242	0.0205	0.0068
F	5.29	6.74	7.42	5.91	5.09	4.45	2.13
p-value	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0156

Source: Own elaboration.

Table 6.
The results of multiple regression for public monetary good

Delay	1Y	5Y	10Y	30Y	50Y	70Y	100Y
Intercept	0.4689	0.3558	0.2686	0.1506	0.0989	0.0859	0.0692
Gender	0.1421	0.0500	0.0268	0.0107	0.0050	0.0028	0.0014
Age	- 0.0017	- 0.0014	- 0.0009	- 0.0004	- 0.0001	- 0.0000	0.0001
Education	0.0042	0.0067	0.0155	0.0076	0.0066	0.0029	0.0029
Household size	0.0115	0.0022	- 0.0006	- 0.0020	- 0.0008	- 0.0005	- 0.0001
Children (below 18)	- 0.0454	- 0.0057	- 0.0085	- 0.0026	- 0.0023	- 0.0008	0.0004

Cont. table 6.

Living place	0.0822	0.0213	0.0130	0.0041	0.0005	- 0.0012	- 0.0016
GZM Metropolis	0.1116	0.0261	0.0156	0.0077	0.0042	0.0001	0.0001
Net income	0.0363	0.0206	0.0096	0.0074	0.0056	0.0048	0.0037
Credit/Loan	0.0285	0.0015	0.0009	0.0014	0.0011	0.0010	0.0016
Savings/investment	- 0.0358	- 0.0082	- 0.0028	0.0009	0.0012	0.0023	0.0021
Creditworthiness	- 0.0123	0.0072	0.0081	0.0048	0.0028	0.0031	0.0026
R^2	0.0089	0.0132	0.0142	0.0135	0.0128	0.0092	0.0106
Adjusted R^2	0.0028	0.0071	0.0082	0.0075	0.0068	0.0031	0.0046
F	1.47	2.19	2.35	2.25	2.12	1.51	1.76
p-value	0.1369	0.0130	0.0070	0.0104	0.0162	0.1195	0.0555

Source: Own elaboration.

Table 7.
The results of multiple regression for public environmental good

Delay	1Y	5Y	10Y	30Y	50Y	70Y	100Y
Intercept	0.4237	0.3070	0.2381	0.1271	0.0879	0.0741	0.0651
Gender	0.0904	0.0542	0.0328	0.0158	0.0096	0.0078	0.0054
Age	- 0.0012	- 0.0013	- 0.0009	- 0.0004	- 0.0003	- 0.0001	- 0.0001
Education	0.0668	0.0100	0.0054	0.0012	0.0018	0.0020	0.0009
Household size	- 0.0162	- 0.0035	- 0.0046	- 0.0025	- 0.0014	- 0.0010	- 0.0008
Children (below 18)	0.0033	0.0025	0.0133	0.0073	0.0060	0.0045	0.0039
Living place	0.0379	0.0048	0.0000	0.0014	- 0.0000	0.0003	- 0.0002
GZM Metropolis	- 0.0161	0.0057	0.0011	- 0.0010	0.0014	0.0001	- 0.0020
Net income	- 0.0006	0.0197	0.0247	0.0109	0.0053	0.0042	0.0032
Credit/Loan	- 0.0002	- 0.0006	0.0001	0.0031	0.0005	0.0010	0.0014
Savings/investment	- 0.0450	- 0.0008	- 0.0010	0.0004	0.0012	0.0012	0.0005
Creditworthiness	- 0.0232	- 0.0042	0.0012	0.0012	0.0001	- 0.0000	- 0.0005
R^2	0.0132	0.0177	0.0191	0.0161	0.0163	0.0142	0.0111
Adjusted R^2	0.0072	0.0117	0.0131	0.0101	0.0103	0.0082	0.0050
F	2.19	2.95	3.19	2.68	2.72	2.35	1.83
p-value	0.0127	0.0007	0.0003	0.0020	0.0017	0.0070	0.0443

Source: Own elaboration.

The results presented lead to the formulation of a conclusion that the two most important factors shaping the level of elicited discount rates are gender and age. Generally, women declared higher interest rates, but this influence was long-term only in case of the public environmental goods. In other cases, it disappeared when considering time horizons longer than 30 years. On the other hand, age diminishes the discount rate for all periods analyzed (with exception for extremely long-term periods in the case of public goods).

It is also visible that discount rates appropriate for private monetary benefits are also rising with the education level of the respondents and the household size (but only for short-term rates, 1-5 years). Higher rates are also declared when the respondent is a borrower (for time horizons up to 10 years), or is convinced that he could borrow an additional amount of money (time horizons between 10 and 70 years). Thus, a set of demographic and socio-economic factors influencing the time preferences of Polish citizens is rather narrow – it includes gender and age, and partially by the education level, household size and being a borrower.

4. Summary and conclusions

In the paper, the time preference of a large sample of Polish citizens was investigated by eliciting and analyzing the individual discount rates. Three different types of goods were analyzed: private monetary benefits, public monetary benefits and public environmental ones. The main conclusions of the study are twofold. First, it has been shown that the individual discount rates decline when lengthening time horizons is considered (and the decline is considerable). These observations lead to the conclusion that the common assumption of the constant discount rate used to evaluate various types of investment projects, including environmental and related to the energy transformation process, should be assessed using the concept of DDR (declining discount rate) as suggested, e.g., by (Buła, Foltyn-Zarychta, 2022).

Table 8

The results of chosen studies devoted to eliciting discount rates for money and other goods

Study	(Cropper et al., 1994)		(Meerding et al., 2010)		(Newell, Siikamaki, 2015)		(Atmadja et al., 2017)		(Green, Richards, 2018)		(Foltyn-Zarychta, 2020)		Current study	
R_{money} vs $R_{environment}$			=						>		>		>	
Sample	3000 households		207 individuals		1217 households		10,000 households		93 individuals		502 individuals		2000 individuals	
Country	USA		Netherlands		USA		India		USA		Poland		Poland	
Good	**M**	**E**	**M**	**H**	**M**	**E**	**M**	**E/H**	**M**	**E**	**M**	**E**	**M**	**E**
Gender		↓	=	↑		↑		↑*	↓*	↓	↓*	↑	↓*	↓*
Age		↑*	↑*	↑*		↑		↓	↓	↑*	↓*	↓*	↓*	↓*
Education		↑	↑*	↑		↓*					↑*	↓*	↑*	↑
Household size						↑*		↑			↑*	↑*	↓*	↓
Children (below 18)		↑*	↑*	↑		?					↓*	↓	?	↑
Living place													↑	?
GZM Metropolis													?	?
Net income			↓	↑	↑*	↓?		↓			↑	↑	?	↑
Credit/Loan													↑*	?
Savings/ investment													?	?
Creditworthiness						↓?		↓*					↑*	?

R_{money} – discount rate for money; $R_{environment}$ – discount rate for environmental goods; M – money; E – environmental goods; H – health; Gender (male – 0, female – 1), Education (high school or lower – 0, post-secondary school or higher – 1), Children under 18 (no – 0, yes – 1), Living place (rural – 0, urban – 1), GZM Metropolis (not an inhabitant of GZM Metropolis – 0, otherwise – 1), Credit/loan (no – 0, yes – 1), Savings/investment (no – 0, yes – 1), Creditworthiness (no – 0, yes – 1); * – statistically different from 0.

Source: Own elaboration.

Second, it has been proved that among various demographic and socio-economic factors affecting the elicited discount rates two are most influential: age and gender (Table 8). Men and the elder tend to declare lower discount rates. However, the analysis of the results of recent studies devoted to this problem does not provide us with clear answers, as the results are often mixed or dependent on the time horizon considered. Moreover, it must be emphasized

that the dominant part of individual discount rate variability is not explained by the abovementioned factors, but rather should be assigned to other, individual-specific features, which is the main limitation of this study, but also creates a chance to extend this analysis to include respondents' values and beliefs as explanatory variables.

Acknowledgements

References

1. Andersen, S., Harrison, G., Lau, M., Rutstrom, E. (2008). Eliciting Risk and Time Preferences. *Econometrica*, *76*(3), 583-618.
2. Atmadja, S.S., Sills, E.O., Pattanayak, S.K., Yang, J.-C., Patil, S. (2017). Explaining environmental health behaviors: Evidence from rural India on the influence of discount rates. *Environment and Development Economics*, *22*(3), 229-248.
3. Bankier.pl (2024). *Bankier.pl*. https://www.bankier.pl/
4. BIK (2024). *Biuro Informacji Kredytowej*. https://www.bik.pl/
5. Bórawski, P., Bełdycka-Bórawska, A., Holden, L., Rokicki, T. (2022). The Role of Renewable Energy Sources in Electricity Production in Poland and the Background of Energy Policy of the European Union at the Beginning of the COVID-19 Crisis. *Energies*, *15*(22), 8771.
6. Buła, R., Foltyn-Zarychta, M. (2022). Declining Discount Rates for Energy Policy Investments in CEE EU Member Countries. *Energies*, *16*(1), 321.
7. Cropper, M.L., Aydede, S.K., Portney, P.R. (1994). Preferences for life saving programs: How the public discounts time and age. *Journal of Risk and Uncertainty*, *8*, 243-265.
8. Dunlap, R.E., Van Liere, K.D. (1978). The "New Environmental Paradigm". *The Journal of Environmental Education*, *9*(4), 10-19. https://doi.org/10.1080/00958964.1978.10801875
9. Foltyn-Zarychta, M. (2020). The Dilemmas of Public vs. Private Goods Discounting for Long-Term Investment Appraisal: The Puzzle of Citizen and Consumer Approaches to Valuation. *Folia Oeconomica Stetinensia*, *20*(2), 114-133.

10. Gollier, C., Weitzman, M. (2010). How should the distant future be discounted when discount rates are uncertain? *Economics Letters*, *107*(3), 350-353.

11. Green, G.P., Richards, T.J. (2018). Discounting environmental goods. *Journal of Agricultural and Resource Economics*, 215-232.

12. GUS (2023). *Główny Urząd Statystyczny*. https://stat.gov.pl/

13. International Energy Agency (2022). *Poland 2022. Energy Policy Review*. https://www.iea.org/reports/poland-2022

14. Lowe, J. (2008). *Intergenerational wealth transfers and social discounting: Supplementary Green Book guidance*. https://www.thenbs.com/PublicationIndex /documents/details? Pub=HMT&DocID=303722

15. Meerding, W.J., Bonsel, G.J., Brouwer, W.B.F., Stuifbergen, M.C., Essink-Bot, M.-L. (2010). Social time preferences for health and money elicited with a choice experiment. *Value in Health: The Journal of the International Society for Pharmacoeconomics and Outcomes Research*, *13*(4), 368-374. https://doi.org/10.1111/j.1524-4733.2009.00681.x

16. Newell, R.G., Siikamaki, J.V. (2015). *Individual Time Preferences and Energy Efficiency* (Working Paper, No. 20969). National Bureau of Economic Research. https://doi.org/10.3386/w20969

17. *Our World in Data* (2024, March 25). Our World in Data. https://ourworldindata.org

18. Richards, T.J., Green, G.P. (2015). Environmental Choices and Hyperbolic Discounting: An Experimental Analysis. *Environmental and Resource Economics*, *62*(1), 83-103. https://doi.org/10.1007/s10640-014-9816-6

19. Stern, P.C. (2000). New Environmental Theories: Toward a Coherent Theory of Environmentally Significant Behavior. *Journal of Social Issues*, *56*(3), 407-424. https://doi.org/10.1111/0022-4537.00175

20. Stern, P.C., Dietz, T., Abel, T., Guagnano, G.A., Kalof, L. (1999). A Value-Belief-Norm Theory of Support for Social Movements: The Case of Environmentalism. *Human Ecology Review*, *6*(2), 81-97.

21. United Nations (2015). Resolution adopted by the General Assembly on 25 September 2015. Transforming our world: The 2030 Agenda for Sustainable Development. In: *Transforming our world: The 2030 Agenda for Sustainable Development*. New York, NY, USA: United Nations.

22. Weitzman, M.L. (1998). Why the Far-Distant Future Should Be Discounted at Its Lowest Possible Rate. *Journal of Environmental Economics and Management*, *36*(3), 201-208. https://doi.org/10.1006/jeem.1998.1052

23. Weitzman, M.L. (2001). Gamma Discounting. *American Economic Review*, *91*(1), 260-271. https://doi.org/10.1257/aer.91.1.260