GAIN AND LOSS OF MONEY IN A CHOICE EXPERIMENT. THE IMPACT OF FINANCIAL LOSS AVERSION AND RISK PREFERENCES ON WILLINGNESS TO PAY TO AVOID RENEWABLE ENERGY EXTARNALITIES.

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1. INTRODUCTION

In nonmarket valuation one of a crucial question is:

- Whether estimated values are sensitive to the direction of price changes?

- If they are: => the standard neoclassical framework (which assumes constant marginal utility of income changes) would not be appropriate for organizing and interpreting the results from stated preference studies.

1. INTRODUCTION

- In the contex of renowable energy development Arevena et al. (2014) find that values stated for changes in the CE attributes are unaffected by the direction of the price change.

- CE studies in other contexts, including sets of public programs, freight transport or water service, conflict with these findings, providing evidence of asymmetrical responses to price increases and decreases regarding the valued attributes (e.g., see Ozdemir, 2016; Masiero and Henscher, 2010; Lanz et al., 2010) => Prospect theory Kahnemann and Tversky (1979).

2. OBJECTIVE OF THE STUDY

The main objectives of the study are:

1. To examine whether marginal WTP is influenced by the direction of changes in the price vector in a particular context - that is renewable energy development.
2. To examine whether the asymmetry apparent in respondents' choices to avoid renewable energy externalities can be explained by economic drivers, such as:
   - financial loss aversion;
   - financial risk preferences.

2. OBJECTIVE OF THE STUDY

Risk preferences in the financial domain:

- Although attributes and their changes are presented in a CE as certain respondents can perceive them as uncertain (e.g. due to the long time horizon)
- On one hand side we can expect that people who are more risk seeking would tend to invest more in uncertain outcome,
- On the other hand, taking into account the public characteristic of some environmental goods, more risk averse individuals might choose to contribute more to the good in order to compensate for the risk of others not contributing.

2. OBJECTIVE OF THE STUDY

Loss aversion in the financial domain:

Whether the discrepancy between WTA and WTP can be explained solely by loss aversion for goods or also by loss aversion for money has been a subject of a few important studies.

- E.g. Bateman et. al. (2005) argue that there is a symmetry between WTA and WTP i.e. the acts of giving up goods when sold for money and giving up money to buy goods are both constructed as losses.
- On the other hand, Tversky and Kahneman (1991) postulate an absence of loss aversion for money in transactions (the act of selling a good for money (WTA) is constructed as a loss of the good, whereas the act of giving up money to buy goods (WTP) is constructed as a foregone gain of money, not a loss).
- Weber at al. (2007) in the study on activation of the amygdala (functional brain region responsible for processing of fear) suggest loss aversion for goods as well as an absence of loss aversion for money in routine transactions.

3. DESIGN OF THE STUDY

I. Valuation – Choice Experiment (CE) concerning renewable energy (wind, solar and biomass) development in a close proximity to respondents' place of residence

- the CE comprised four labeled alternatives
- the choice sets were created using a Bayesian efficient design
- the final design comprised 24 choice sets that were blocked into 4 subsets
- the order of choice sets appearance was randomized as was the order of the first three labelled alternatives.
- Cost attribute - changes in electricity bill => Increases and decreases of the electricity bills were presented simultaneously in the same choice tasks

II. Risk preferences and loss aversion elicitation – the multiple price list (MPL) with paired lotteries designed by Tanaka et al. (2010)

- individuals were presented with 3 series of lottery pairs (A and B) and asked to choose one lottery for each pair,
- when moving down the list of lotteries, payoffs in Option B increased while everything else was fixed.
- the lotteries were designed in a way that any combination of choices in the 3 series determines a particular interval of prospect theory parameter values

CE DESIGN – ATTRIBUTES & LEVELS

Attribute	Attribute label	Attribute level
Minimum distance to residential areas	Distance	300m; 600m; 900m (FSQ); 1600m; 2500m
Size of renewable energy production sites	REPS size	small; medium (FSQ), large
Number of renewable energy production sites	REPS number	1; 2; 3 (FSQ); 4; 5
Share of landscape not used for renewable energy expansion	Landscape	10%; 20%; 30% (FSQ); 40%; 50%
High-voltage transmission lines	HVTL	overhead (FSQ); underground
Monthly change in energy bill (annually)	Cost	-20 zł (-240 zł); -10 zł (-120 zł); 0zł (FSQ); +5 zł (+60 zł); +15 zł (+180zł); +30 zł (+360 zł); +50 zł (+600 zł)**

The CE designe has been applied from the Energy EFFAR project: „Efficient and fair allocation of renewable energy production at the national level, Fkz.01LA1110A - funded by the Federal Ministry of Education and Research in Germany”

CE DESIGN – CHOICE SET EXAMPLE

	Electricity from wind	Electricity from biomass	Electricity from solar	"Do not care"
Minimum distance to residential areas	600m	2500m	300m	900m
Size of renewable energy production sites	Large (35-50 turbines)	Large (15-25 fermentation tanks)	Small (0.5 – 5 hectares)	Medium
Number of renewable energy production sites	4	5	5	3
Share of landscape not used for renewable energy expansion	20%	50%	10%	30%
High-voltage transmission lines	underground	underground	overhead	overhead
Monthly change in energy bill (annually)	+30zł (+360zł)	-10zł (-120zł)	+30 (+360zł)	0 zł
Choice	☐	☐	☐	☐

SERIES 1

Option A				Option B				EV(A)-EV(B)
Prob.	Payoff	Prob.	Payoff	Prob.	Payoff	Prob.	Payoff	
0.3	400 zł	0.7	100 zł	0.1	680 zł	0.9	50 zł	77 zł
0.3	400 zł	0.7	100 zł	0.1	750 zł	0.9	50 zł	70 zł
0.3	400 zł	0.7	100 zł	0.1	830 zł	0.9	50 zł	62 zł
0.3	400 zł	0.7	100 zł	0.1	930 zł	0.9	50 zł	52 zł
0.3	400 zł	0.7	100 zł	0.1	1 060 zł	0.9	50 zł	39 zł
0.3	400 zł	0.7	100 zł	0.1	1 250 zł	0.9	50 zł	20 zł
0.3	400 zł	0.7	100 zł	0.1	1 500 zł	0.9	50 zł	-5 zł
0.3	400 zł	0.7	100 zł	0.1	1 850 zł	0.9	50 zł	-40 zł
0.3	400 zł	0.7	100 zł	0.1	2 200 zł	0.9	50 zł	-75 zł
0.3	400 zł	0.7	100 zł	0.1	3 000 zł	0.9	50 zł	-155 zł
0.3	400 zł	0.7	100 zł	0.1	4 000 zł	0.9	50 zł	-255 zł
0.3	400 zł	0.7	100 zł	0.1	6 000 zł	0.9	50 zł	-455 zł
0.3	400 zł	0.7	100 zł	0.1	10 000 zł	0.9	50 zł	-855 zł
0.3	400 zł	0.7	100 zł	0.1	17 000 zł	0.9	50 zł	-1 555 zł

SERIES 2

Option A				Option B				EV(A)-EV(B)
Prob.	Payoff	Prob.	Payoff	Prob.	Payoff	Prob.	Payoff	
0.9	400 zł	0.1	300 zł	0.7	540 zł	0.3	50 zł	-3 zł
0.9	400 zł	0.1	300 zł	0.7	560 zł	0.3	50 zł	-17 zł
0.9	400 zł	0.1	300 zł	0.7	580 zł	0.3	50 zł	-31 zł
0.9	400 zł	0.1	300 zł	0.7	600 zł	0.3	50 zł	-45 zł
0.9	400 zł	0.1	300 zł	0.7	620 zł	0.3	50 zł	-59 zł
0.9	400 zł	0.1	300 zł	0.7	650 zł	0.3	50 zł	-80 zł
0.9	400 zł	0.1	300 zł	0.7	680 zł	0.3	50 zł	-101 zł
0.9	400 zł	0.1	300 zł	0.7	720 zł	0.3	50 zł	-129 zł
0.9	400 zł	0.1	300 zł	0.7	770 zł	0.3	50 zł	-164 zł
0.9	400 zł	0.1	300 zł	0.7	830 zł	0.3	50 zł	-206 zł
0.9	400 zł	0.1	300 zł	0.7	900 zł	0.3	50 zł	-255 zł
0.9	400 zł	0.1	300 zł	0.7	1 000 zł	0.3	50 zł	-325 zł
0.9	400 zł	0.1	300 zł	0.7	1 100 zł	0.3	50 zł	-395 zł
0.9	400 zł	0.1	300 zł	0.7	1 300 zł	0.3	50 zł	-535 zł

SERIES 3

Option A				Option B				EV(A)-EV(B)
Prob.	Payoffs	Prob.	Payoffs	Prob.	Payoffs	Prob.	Payoffs	
0.5	250 zł	0.5	-40 zł	0.5	300 zł	0.5	-210 zł	60 zł
0.5	40 zł	0.5	-40 zł	0.5	300 zł	0.5	-210 zł	-45 zł
0.5	10 zł	0.5	-40 zł	0.5	300 zł	0.5	-210 zł	-60 zł
0.5	10 zł	0.5	-40 zł	0.5	300 zł	0.5	-160 zł	-85 zł
0.5	10 zł	0.5	-80 zł	0.5	300 zł	0.5	-160 zł	-105 zł
0.5	10 zł	0.5	-80 zł	0.5	300 zł	0.5	-140 zł	-115 zł

4. RISK - PROSPECT THEORY (PT)

Value function:

$$v(x) = \begin{cases} x^{\sigma} \; if \; x \geq 0 \\ -\lambda(-x)^{\sigma} \; if \; x < 0 \end{cases}$$

where *x* is an outcome, **σ represents concavity** of the value function and **λ is the degree of loss aversion**. If an individual is risk loving then σ>1, if she is risk neutral then σ=1, and risk averse if σ<1.

λ can take only positive values. It measures one's sensitivity to loss compared to gain. The higher the value of λ, the more loss averse an individual is.

Probability weighting function:

$$\pi(p) = \frac{1}{\exp\left[\ln\left(\frac{1}{p}\right)\right]^{\alpha}}$$

where *p* is the probability of the outcome x and α is the probability sensitivity parameter.

4. RISK – PROSPECT THEORY

PT utility function for a two outcome gamble:

$$U(x,p;y,q) = \begin{cases} \pi(p)v(x) + \big(1-\pi(p)\big)v(y) & if\ x > y > 0\ or\ x < y < 0 \\ \pi(p)v(x) + \pi(q)v(y) & if\ x < 0 < y \end{cases}$$

where: *x* and *y* are the outcomes, and *p* and *q* are probabilities associated with those outcomes.

5. ECONOMETRIC APPROUCH

- MXL model;
- All non-cost atrtributes were specified to follow a normal distribution; COST followed a log-normal distribution,
- Cost enters as two variables allowing for a different parameter of the marginal utility of money when one chooses an alternative with:
  - the cost to be paid ('cost positive') – SURCHARGE on a current electricity bill
  - the cost decreasing ('cost negative') - REBATE on a current electricity bill
- risk preferences and loss aversion enter the model via interaction effects with the SURCHARGE and REBATE attributes
- both λ (loss aversion) and σ (risk preferences) are normalized.

6. DATA

- N = 800;
- quota sample representative of the Polish population in terms of:
  - gender,
  - age,
  - agglomeration size,
  - geographical location;
- carried out by a professional polling agency in January 2016;
- face-to-face, CAPI;
- subjects excluded from the analysis:
  - those who never switched in the CE and in the lottery tasks (56) => N= 744

	Share	Mean	Median	Min	Max
Women	53%				
Age		49	50	19	86
Education					
- **Primary**	37%				
- **Secondary**	35%				
- **High**	28%				
Net monthly individual income in zł		1965	1500	500	15000

Note: Nominal exchange rate 1€ = 4.36zł (January 2016)

7. RESULTS

	Mean	St. dev.	Median
Risk preferences	0.81	0.48	0.85
Loss aversion	2.61	3.64	1.11

Average value of loss aversion parameter significantly diffrent from 1 (t-test, p=0.001)
=> respondents weighted losses more heavily than equivalent gains (PT)

Variable	Distribution	Means (s.e.)	St. dev. (s.e.)
ASC_wind energy	Normal	2.7250*** (0.3637)	5.2560*** (0.4184)
ASC_biomass energy	Normal	1.4557*** (0.3717)	4.7420*** (0.4273)
ASC_solar energy	Normal	4.8052*** (0.3802)	5.6042*** (0.4089)
Distance	Normal	0.3861*** (0.0629)	0.6206*** (0.0881)
REPS size	Normal	-0.0349 (0.0854)	0.4307*** (0.0948)
REPS number	Normal	-0.0775* (0.0466)	0.2437*** (0.0630)
Landscape	Normal	0.5860* (0.3433)	2.3734*** (0.6671)
HVTL	Normal	0.2175** (0.1024)	1.0987*** (0.3786)
Rebate per month (income increase) in Euro	Lognormal†	**-5.4470*** **(1.1679)**	**3.3359*** **(0.6163)**
x λ (loss aversion)		**-0.9641*** **(0.3503)**	
x δ (risk preferences)		**0.5293*** **(0.2723)**	
Surcharge per month (income decrease) in Euro	Lognormal	**-1.5340*** **(0.1538)**	**2.1267*** **(0.1695)**
x λ (loss aversion)		**-0.0134** **(0.1213)**	
x δ (risk preferences)		**-0.4726*** **(0.1231)**	
Model diagnostics			
LL at convergence		-5670.44	
McFadden's pseudo-R^2		0.3532	
Number of individuals		744	
Number of parameters		69	

8. CONCLUSIONS

- Respondents treated the alternatives presented on the choice sets clearly differently depending on whether they would have to pay a surcharge or whether they would receive a rebate,
- **Marginal utility of money seems to be lower with a rebate than with a surcharge,**
- Financial risk preferences and loss aversion for money impacts peoples' choices in the case of a rebate,
- Financial risk preferences appeared to impact peoples' choices in a case of a surcharge,
- Loss aversion for money seems to not be present during a "buying" process.

8. CONCLUSIONS

- The more loss averse for money people are, they require more compensation before they accept externalities from renewable electricity production.
- The more risk seeking people are in a financial domain they are willing to pay more for proposed changes in renewable energy development,
- The more risk seeking people are in a financial domain they require lower compensation for accepting renewable energy externalities.

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