FONDAZIONE ENI ENRICO MATTEI

PURGE – Public health impacts in URban environments of Greenhouse gas Emissions reduction strategies

Preferences for Energy Efficiency vs. Renewables: How Much Does a Ton of CO_2 Emissions Cost?

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Introduction: Summary of main results

Respondents:

- prefer policies for renewables over policies for energy efficiency

- In Italy, they clearly prefer incentive-based policies and disapprove taxes. They are neutral in Czech Republic

- In Italy their willingness to pay is **€130** per ton of CO_2 emissions avoided - **CZK 1,514 (€56)** in the Czech Republic

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Questionnaire Design - Conjoint choice

Elicits preferences for public programs and policies

- estimate the benefits of climate change mitigation, in terms of the public's WTP
- study the attitudes of Italian and Czech households towards climate change mitigation policies related to residential energy use

Policies are described in stylized fashion by four attributes

- Goal: Energy Efficiency or Renewables
- Approach: Incentives, standards, information, fossil fuel taxes
- CO_2: CO_2 emissions reductions per family per year (over 10yr)
- Cost: Cost in euro per family per year (over 10 years)

Summary of attributes used in the conjoint choice experiments

Attribute	Attribute levels	n. levels
goal of the policy	energy efficiency, renewables	2
mechanism(s)	incentives, regulation, taxes on fossil fuels, information-based approaches	7
reduction in CO_2 emissions (for each of 10 years)	0.25 tons (5%), 0.50 tons (10%), 1 ton (20%), 1.65 (33%)	4
cost to the household for each of 10 years (euro)	25, 50, 100, 300	4

Questionnaire Design

Example of Choice Card

E6.Consideriamo due politiche, la politica A e la politica B, descritte di seguito assieme alla situazione attuale:

	Politica A	Politica B	Situazione attuale
Obiettivo della politica	energia da fonti rinnovabili	efficienza energetica	--
Approccio utilizzato	tasse sui combustibili fossili + informazione	standard minimi	--
Riduzione delle emissioni di CO_2 per famiglia (per anno per prossimi 10 anni)	1,65 tonnellate (Riduzione del 33%)	0,5 tonnellate (Riduzione del 10%)	0
Costo della politica per la sua famiglia (in euro per anno per i prossimi 10 anni)	300 euro	100 euro	0 euro

- ○ Politica A
- ○ Politica B
- ○ Nessuna delle due - preferisco la situazione attuale.

Survey

- Identical questionnaire in ITALY and CZE for renewables/energy efficiency policies, and the associated discrete choice experiments with identical design of the choice experiments.
- CAWI survey

In Italy

- Wave 1 on energy usage upgrades, new appliances, gas and electricity consumption and bills, motor vehicles owend conducted in May – June 2013 (N=3015)
- The Wave 1 study informed this survey about residential energy use (Alberini and Bigano, 2014)
- 1005 wave 1 respondents interviewed in July 2014

Meanwhile, in the Czech Republic

- Survey with emphasis on recent or planned purchases of appliances such as refrigerators and washing machines.
- 1385 completed questionnaires in Aug – Sept 2014, on a sample representative of the Czech population in terms of geography, age, education and income.

Econometric approach

Random utility model

$$\overline{V}_{ij} = \alpha_1 \cdot \mathbf{G}_{ij} + \alpha_2 \cdot \mathbf{M}_{ij} + \alpha_3 \cdot \Delta CO2E_{ij} + \beta \cdot (y - C_{ij})$$

On appending an i.i.d. standard type I extreme value error term, ε

$$V_j = \mathbf{x}_j \boldsymbol{\alpha} + \varepsilon_j = \overline{V}_j + \varepsilon_j,$$

the probability that alternative k is chosen is

$$\Pr(k) = \exp(\overline{V}_k) / \sum_{j=1}^{3} \exp(\overline{V}_j)$$

When a respondent is asked to examine T choice cards, the log likelihood function is

$$\log L = \sum_{i=1}^{N} \sum_{t=1}^{T} \sum_{k=1}^{3} y_{itk} \cdot \ln\left(\exp(\overline{V}_{itk}) \Big/ \sum_{j=1}^{3} \exp(\overline{V}_{itj}) \right)$$

$$MWTP_m = -\hat{\alpha}_m / \hat{\beta}$$

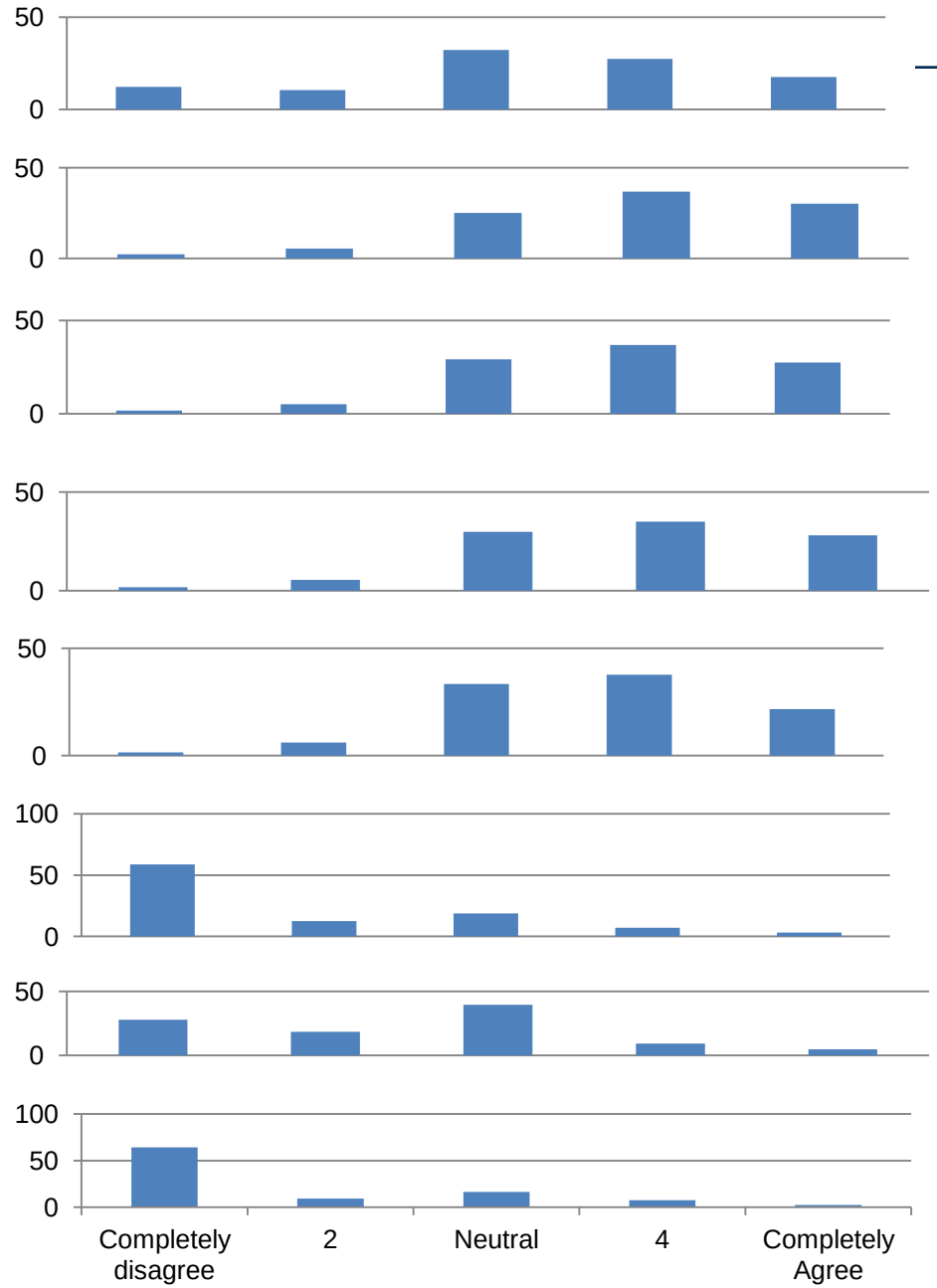
hats denote the maximum likelihood estimates.

Socio-demographic features of respondents in the samples

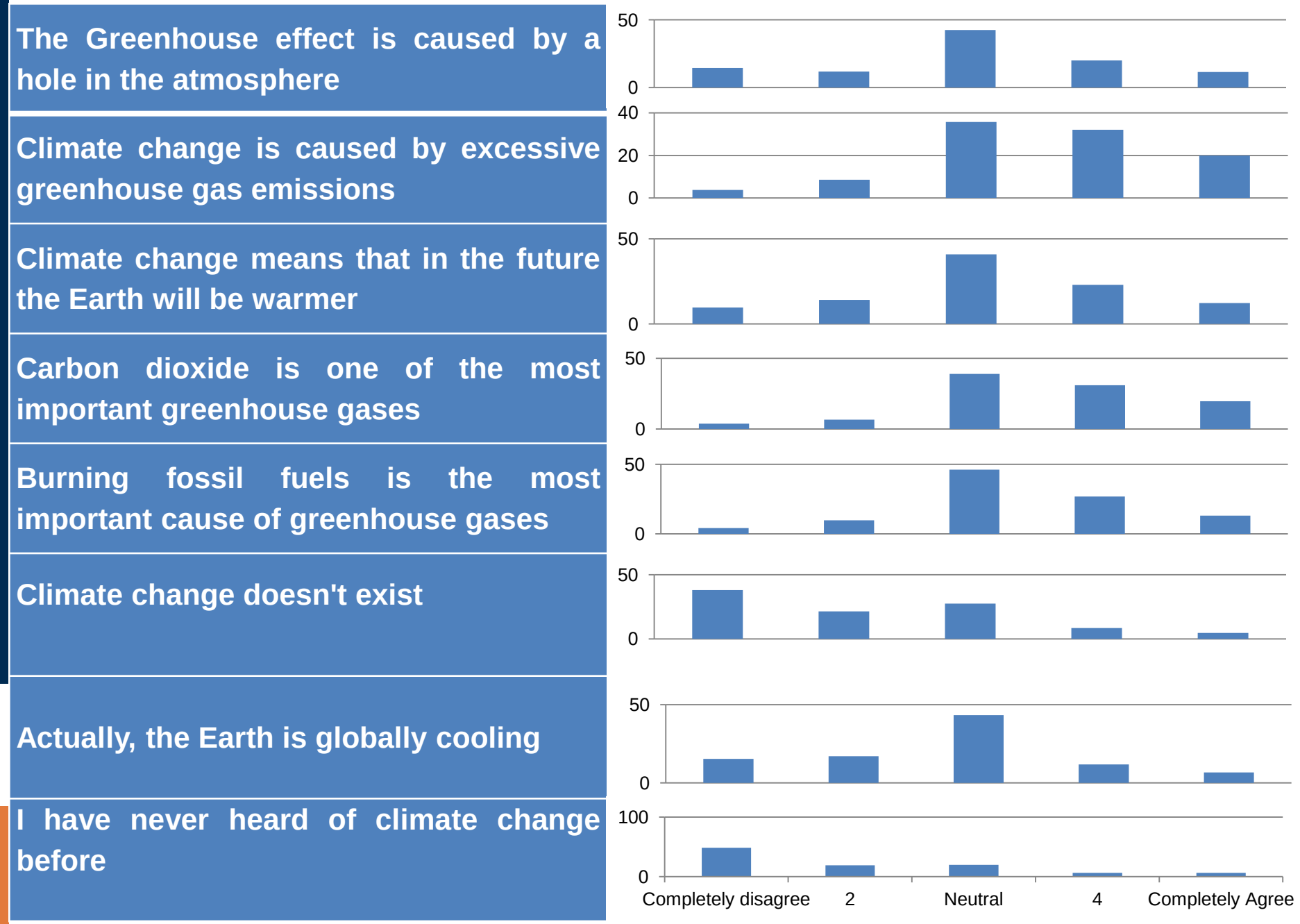
	Italy: Percent or sample mean	Czech Republic: Percent or sample mean
Gender		
Male	61.59%	49.68%
Education		
high school diploma	47.78%	35.96%
college degree	26.47%	4.26%
Master's or PhD	7.16%	9.96%
Annual household income (after tax):		
Mean	€30,284	€13,000 (€pps21,944)
Median	€27,500	€12,445 (€pps21,000)
Missing income (refused)	12.54%	20.00%

Italian Respondents' opinions about climate change (%)

The Greenhouse effect is caused by a hole in the atmosphere
Climate change is caused by excessive greenhouse gas emissions
Climate change means that in the future the Earth will be warmer
Carbon dioxide is one of the most important greenhouse gases
Burning fossil fuels is the most important cause of greenhouse gases
Climate change doesn't exist
Actually, the Earth is globally cooling
I have never heard of climate change before



Czech Respondents' opinions about climate change (%)



Results: Conditional logit model, full sample

	Italy		Czech Republic	
	Coeff.	T stat.	Coeff.	T stat.
Energy efficiency	0.3490***	3.84	0.1276*	1.65
Renewables	0.5425***	5.96	0.2015**	2.57
Incentives	0.2919***	3.98	0.2177***	3.42
Tax	-0.1382***	-3.19	-0.0370	-0.98
Standards	0.1191	1.61	0.1643**	2.59
Info	0.1390*	1.82	0.1310**	1.99
Emissions reduction	0.4292***	11.28	0.3709***	11.21
Cost	-0.0033***	-15.98	-0.00024***	-22.18
N.obs	15,075		20,775	
log likelihood	-5157.17		-7244.36	
LR test of the null that all coefficients are zero	726.71		727.06	
P value	0.00000		0.00000	

Result: Implicit WTP values

	ITALY	CZECH
energy efficiency	€ 106	€ 19
renewables	€ 164	€ 30
Incentives	€ 88	€ 33
Tax	-€ 42	-€ 6
Standards	€ 36	€ 25
Info	€ 42	€ 20
emissions reduction	€ 130	€ 56

Summary of results

- Respondents prefer:
  - policies for renewables over policies for energy efficiency,
  - incentive-based policies and disapprove of policies that impose taxes (more strongly in Italy).
  - policies that yield larger CO_2 reductions
  - policies that cost less

- Their WTP is €130 (Italy) and CZK 1,514 ≈ €56 (Czech Republic) per ton of CO_2 emissions avoided. In 2013 PPP Euro these are €126 and €86.
- Their ratio is the same as mean annual household income ratio, hence income elasticity of WTP = 1.

Conclusions

- Households are willing to pay a significant amount per ton of CO_2 emissions reductions delivered by public programs.

- Results are significant and robust to the eligibility for energy efficiency incentives (coefficients and WTP virtually the same in restricted sample regression).

- Comparing with WTP estimates in the literature:
  - Longo et al.(2012): Basque Country, €57/ton CO_2 for renewable electricity, and €332/ton for energy efficiency.
  - Diederich and Goeschl (2014): Germany, WTP to retire an emissions allowance from the European Trading System: €6/ton CO_2.
  - Datta (2014) estimated the cost per ton of carbon saved for the cloathes washers US ENERGY STAR program at $140 ($38 per t CO2)

- Comparing with the first wave in Italy, cost effectiveness estimate (€279/ton CO_2) the current policy is twice as expensive than what Italian households would be prepared to support (€130/ton CO_2).

Thank you!

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Estimation result, Czech respondents
Policies to support RES & EE

	Model Ia			Model Ib			Model Ic		
	Coef.	z	P>|z|	Coef.	z	P>|z|	Coef.	z	P>|z|
Energy Efficiency	0.1918	3.84	0.0000	0.0913	1.1	0.2730	0.1486	2.12	0.0340
Renewables	0.2698	5.21	0.0000	0.1592	1.89	0.0590	0.2165	3	0.0030
Incentives				0.2382	3.48	0.0000	0.1680	2.41	0.0160
Standards				0.1641	2.4	0.0160	0.1241	1.69	0.0910
Information				0.1035	1.47	0.1420	0.0322	0.41	0.6800
Taxes				-0.0804	-1.97	0.0480	-0.1406	-1.85	0.0640
Taxes + Incentives							0.1095	1.44	0.1500
Taxes + Standards							ref		
Taxes + Informations							-0.0591	-0.76	0.4500
CO_2 abated	0.3696	10.53	0.0000	0.3782	10.67	0.0000	0.3790	10.68	0.0000
COST	-0.0002	-20.33	0.0000	-0.0002	-20.43	0.0000	-0.0002	-20.24	0.0000
N	18150			18150			18150		
LR chi2(df)	597.71			622.25			622.77		
t test (EE=RE), chi2, Prob	4.33		0.0374	3.26		0.0708	3.25		0.0713
Kč per t CO_2	1 539 Kč			1 556 Kč			1 566 Kč		
Euro(ER) per t CO_2	55.98 €			56.57 €			56.93 €		