Willingness to pay for green electricity in the Czech Republic

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Overview

We estimate the willingness to pay of households for electricity generated from renewable energy in the Czech Republic. Discrete choice experiment is used to elicit preferences for various attributes of renewable electricity support scheme (PM emission, GHG emission, size of RE power plant, revenue distribution, and costs). Original survey is carried with 404 respondents living in two regions – Ustecky (polluted area) and Southern Bohemia (cleaner area).

To our knowledge our research is novel in several aspects: the experimental design allows us to elicit preferences for i) decentralized vs. centralized production of green electricity, ii) and for reduction in two complementary substances, local air pollution and global greenhouse gases emissions, iii) to explore whether preferences differ in relatively more polluted region and iv) it proves the WTP estimates for a transit country from CEE region for that such values have not been provided yet.

<u>Renewable Electricity in the Czech Republic</u>

Directive 2009/28/EC set up the mandatory target for the Czech Republic of 13% share of energy from renewable sources in gross final energy consumption and 10% share of energy from renewable sources in transport by 2020.

In 2005, the Czech Republic introduced feed-in tariffs (FIT) and feed-in premiums (FIP) in order to promote renewable electricity sources.

Payment for the support of renewable electricity (which is further redistributed to renewable electricity producers in form of feed-in-tariff) is compulsory component of the electricity final price. It is regulated and is computed from actual consumption of electricity (kWh) equally for every consumer (household, company). It consists of approx. 10% of final electricity price paid.

Willingness to pay for green electricity – State of the art

To summarize the results of literature review, the vast majority of studies conclude that there exists a positive value of willingness to pay of households for renewable energy sources. The attributes with greatest influence on value of WTP are: i) expected change of air quality, ii) type of beneficiary (decentralization), iii) location of production, iv) environmental attitude of the respondent, v) income of the household and vi) level of household's electricity consumption.

Methods

The discrete choice method was used which is a general preference elicitation approach that asks agents to make choice(s) between two or more discrete alternatives where at least one attribute of the alternative is systematically varied across respondents in such a way that information related to preference parameters of an indirect utility function can be inferred.

Econometric model

Multinomial (MNL) model was used since it allows modelling relationships between a polytomous response variable and a set of regressor variables. More specifically a conditional logit model was used in which a choice among alternatives is treated as a function of the characteristics of the alternatives (e.g. level of air quality or level of centralization).

In the conditional logit model, the explanatory variables assume different values for each alternative and the impact of a unit of explanatory variables is assumed to be constant across alternatives (ibid.). When explanatory variables contain only individual characteristics, the multinomial model is defined as

$$P(y_i = j) = P_{ij} = \left[\exp\left(x_i'\beta_j\right) / \sum_{k=0}^{J} \exp(\, x_i'\beta_k)\right] for\; j = 0, \dots, J$$

Where y_i is a random variable that indicates the choice made, x_i is a vector of characteristics specific to the individual and βj is a vector of coefficients specific to the *j*th alternative. Thus, this model involves choice-specific coefficients and only individual specific regressors.

The ratio of the choice probabilities for alternatives *j* and *i* or the odds ratio of alternatives *j* and *i*. The log-likelihood function of the MNL model is

$$L = \sum_{i=1}^{N} \sum_{j \epsilon c_i} d_{ij} lnP(y_i = j)$$

Where d_{ij} = 1 if individual i chooses alternative j, d_{ij} = 0 otherwise.

The conditional logit model can be used to predict the probability that an individual will choose a previously unavailable alternative, given knowledge of β and the vector x_{ij} of choice-specific characteristics.

The variety in the parameters at the individual level may be demonstrated using the maximum simulated likelihood (MSL) method for estimation with a set of 100 Halton draws (Louviere et al., 2000; Bhat, 2001). Since each respondent completes same amount of discrete choice questions, the data form a panel, and we can apply standard random effect estimation.

When we expect that variables are linear in parameters, we may express the utility function as

$$U_{nit} = \gamma\,' x_{nit} + \beta_n' z_{nit} + \varepsilon_{nit}$$

where γ denotes a fixed parameter vector, β_n denotes a random parameter vector, x_{nit} and z_{nit} denote observable variables, and ε_{nit} denotes an independently and identically distributed extreme value term.

Economic model

The model was developed from a simple model that was initially used for pilot experiment in accordance with results of pilot experiment outcomes of literature.

$$\begin{aligned} U_i = a_1 * EBILL_i + b_1 * PM_i * INCOME_i + c_1 * PM_i * REGION_i + d_1 * PM_i * ATTITUDE_i \\ + e_1 * PM_i * AIRpoll_i + b_2 * CC_i * INCOME_i + c_2 * CC_i * REGION_i + d_2 \\ * CC_i * ATTITUDE_i + e_2 * CC_i * AIRpoll_i + f_1 * HH_i + f_2 * MUN_i + f_3 \\ * REG_i + f_4 * NAT_i + g_1 * ALLOC_i \end{aligned}$$

Data

Each choice set presented to respondents in the experiment includes three alternatives from which a respondent was asked to choose one alternative that by his/her expectation would bring him/her highest level of utility. The status quo alternative (that is respondent-specific) was presented in each choice set. The levels of attributes in the alternatives varied according to the choice set that was randomly chosen from a block that was attributed to each respondent (at random).

In order to set up an efficient design of a questionnaire 80 choice sets were defined. Choice sets were divided 8 in 10 blocks. Blocks were randomly distributed among respondents,

The design was optimized for D-efficiency (Sándor and Wedel 2001; Ferrini and Scarpa 2007) of the MNL model using Bayesian priors (Huber and Zwerina, 1996; Scarpa and Rose, 2008). The efficiency was evaluated by simulation (a median of 1000 Sobol draws, see Rose and Bliemer, 2008) à 80 choice-tasks, blocked into 80/10 questionnaire versions with 10 choice tasks per ID.

The survey was administered in term June 18th – June 22th 2015 in 2 regions of the Czech Republic, in accordance with demographic distribution of the population. The CAWI method was used.

Preliminary results

We find that respondents prefer decentralized renewable electricity sources over centralized, local air quality improvements over reduction in greenhouse gas emissions. Estimated marginal willingness to pay for 1% reduction in emission of particulate matter equals to 49 CZK, respectively 3.7 % of average monthly electricity bill. In total, WTP for green electricity is larger than current compulsory contributions to renewable energy support scheme.