

Does Money Talk?

- The Effect of a Monetary Attribute on the Marginal Values in a Choice Experiment

Claudia Aravena^a, Peter Martinsson^b, Riccardo Scarpa^c

Forthcoming in *ENERGY ECONOMICS*

Accepted February 24th, 2014

ABSTRACT

When designing choice experiments for nonmarket valuation the role of the price attribute is of major importance. In the energy sector the uncertainty of future direction of changes in prices makes it difficult to include an adequate price vector in the design. We separately investigate the implication of using price vectors with increases and decreases in tariffs from current levels, on marginal value estimate from choice experiment data developed using prospect theory. In addition, we also analyse the effect of excluding the price vector on these marginal values. By and large, our results support the neoclassical theory as we find that the means of the conditional estimates of the marginal values of attributes are unaffected by the direction of the price change and from exclusion of the price attribute. However, the distributions show a larger spread of values when the experiment implies a tariff decrease, which may have policy implications.

JEL Classification: C93 ; D12 ; Q40.

Key-words: Choice experiment; prospect theory; wind power.

^a Department of Economics. Trinity College Dublin. Arts Building, Dublin 2. Ireland - E-mail: aravenac@tcd.ie. (Corresponding author).

^b Department of Economics, University of Gothenburg, Box 640, 405 30 Gothenburg, Sweden; E-mail: peter.martinsson@economics.gu.se.

^c Gibson Institute for Land, Food and Environment. School of Biological Sciences. Queen's University Belfast, Belfast. UK and Department of Economics, Waikato Management School, University of Waikato, New Zealand; E-mail: r.scarpa@qub.ac.uk.

1. Introduction

To combat climate change, the energy sector has undergone major changes during the last decade. The most notable change is the increased investments in renewable sources of energy generation. Another feature of changes in the energy sector is the deregulation of the energy market, where one of the key issues is to establish incentives for the agents to undertake optimal investment from a societal perspective to ensure reliable supply of power. As a result, policymakers as well as other agents in the energy sector, need to use stated preference studies to evaluate many of the discussed changes, e.g., to value the environmental impacts of building a new wind farm or the decreased probability of future power outages (e.g., Bergmann et al., 2006; Borchers et al., 2007; Carlsson and Martinsson, 2008; Carlsson et al., 2011; Ek, 2005; Groothuis et al., 2008; Hanley and Nevin, 1999; Koundouri et al., 2009; Ladenburg et al., 2005; Longo et al., 2008; Meyerhoff et al., 2010; Scarpa and Willis, 2010). Since many of the suggested changes in the energy sector involve simultaneous changes of many attributes, choice experiments have been frequently applied. A choice experiment study provides policy makers with the marginal rates of substitution (MRS) between different attributes, most often between a non-monetary and a monetary attribute¹ expressed as marginal willingness to pay (WTP). The estimated WTP may then be directly included in economic evaluations such as cost-benefit analyses.^{2,3}

¹ We use the terms “monetary attribute” and “price attribute” interchangeably throughout the paper.

² For overviews on the choice experiment method see e.g., Adamowicz and Deshazo, 2006; Alpizar et al., 2003; Louviere et al., 2000.

³ The most popular stated preference method to date is the contingent valuation. A contingent valuation study focuses on the total WTP for a discrete change, often including several simultaneous changes (for example, a simultaneous change of both source of energy generation and reliability of power supply). In contrast, in a choice experiment each attribute is evaluated separately. To facilitate the analyses of marginal values, the design of a choice experiment is such that each respondent is asked to repeatedly choose her preferred alternative (or project) from a choice set that normally consists of two or three

The main objective of this paper is to study whether the marginal values, i.e., marginal WTP and MRS and their respective distributions, are affected by the direction of change in the price vector, described either as an increase or a decrease from the current price level in a choice experiment, with an application to the energy sector in Chile. A key consideration in our analysis is whether prospect theory, as originally devised by Kahneman and Tversky (1979) in a gambling situation and later extended to also include the case with certain outcomes in Tversky and Kahneman (1991), according to which gains and losses from a reference point are valued differently, can explain behavioural responses to different directions (increased and decreased) of change for the price attribute. Or indeed, whether the observed differences can be adequately explained by neoclassical theory, where changes from a reference point are, at the margin, valued equally.

The uncertainty regarding the direction of change in price is a salient reality in the energy sector. The effect on the electricity price paid by consumers due to the introduction of new sources of energy generation or to the reduction in probability of future power outages is often uncertain. This is partly related to the uncertainty surrounding future production costs, technology development as well as to the direction and extent of changes in taxes and subsidies in the energy sector. These factors make it difficult to design a choice experiment. However, if the marginal values are sensitive to the direction of change in the price vector then, in any valuation study, it is extremely important to correctly determine the absolute level of price changes, which of course includes the direction of change in price from the current level. At a broader perspective, the possibilities to generalize the results from one study to another, e.g., by

alternatives. Each alternative is described by a number of attributes and each attribute is assigned one of several possible levels.

using benefit transfer, are also limited if the marginal values are sensitive to the direction of changes in prices.⁴

In the empirical analyses of choice experiment data, linear-in-attributes utility function is often assumed and is considered a reasonable assumption for small enough changes. It is often implicitly assumed that the estimated marginal WTP and MRS from a choice experiment should be unaffected by the direction of a small price change (as long as the difference in absolute levels between the prices remain the same). However, frequent research, especially in psychology, has shown that preferences are reference-dependent; people's behaviour is affected by a reference price, which in our case corresponds to the current price level. Kahneman and Tversky (1979) formulated the so-called prospect theory, showing that people react differently to gains and losses related to the reference point in gambles (see also e.g., Thaler, 1985). Tversky and Kahneman (1991) extended their previous findings to also include the case with certain outcomes. The basic feature of the reference dependence is illustrated by an S-shaped value function around the reference point. The function is concave above the reference point, and convex below the reference point showing that the marginal utility for a loss is larger than for a gain by using separate value functions in the two different domains. This has been tested experimentally, where subjects either are endowed with a good or had the possibility to buy the same good. The experimental findings support prospect theory since whether or not a subject is endowed with the good significantly affects her

⁴ In a similar vein, there are a number of choice experiments investigating the effect of scaling the price vector included, and the results from empirical studies are mixed. Hanley et al. (2005) investigate in a split sample approach how a design with two different, but overlapping monetary vectors (expressed as a price), affect the estimated marginal WTPs for attributes. In a pair-wise choice experiment with an opt-out option on water quality, they find that marginal WTPs do not differ significantly between the price vectors, but the proportion of subjects choosing the status-quo alternative increases, as expected, when respondents face a higher price. On the other hand, Carlsson and Martinsson (2008) find that adding a constant to the price vector in the original design results in a significantly higher marginal WTP compared to marginal WTP from the original design.

valuation of the change (e.g., Bateman et al., 1997; Kahneman et al., 1990; Knetsch, 1989). However, in an overview paper, Mazumdar et al. (2005) summarize several marketing studies investigating the effect of asymmetric reference price on choices⁵, i.e., when observed price of a good differs from the reference price of the consumer, where the overall findings when comparing previous studies weakly supports prospect theory. However, as discussed in Mazumdar et al., 2005, the effect diminishes when segmenting people according to price sensitivity and brand loyalty. On the other hand, List (2003) and List (2004) find support for the idea that neoclassic theory explains behaviour among people with experience of the good.⁶

More recently, prospect theory has been explicitly investigated in choice experiments. Some studies have investigated reference point when analysing gains and losses in transportation studies. For example, Hess et al. (2008) find evidence of asymmetrical responses to increases and decreases in attributes (travel time and travel cost) compared to the reference alternative in a study of choices on tolled routes. Masiero and Hensher (2010) investigate prospect theory in a choice experiment applied to freight transport to see whether changes in the transport costs affect the marginal willingness to pay and willingness to accept for other attributes and find support for prospect theory. They show consistent disparity between the two measures, with loss in benefits being higher than gains.⁷ Apart from some studies exploring preferences for

⁵ In the marketing literature the reference price is defined as “predictive price expectation that is shaped by consumers’ prior experience and current purchase environment” (Mazumdar et al., 2005, p.85).

⁶ List (2003) investigates prospect theory in the market place by conducting a field experiment on sports memorabilia. He finds that the behaviour among experienced traders is best described by the neoclassic theory, while prospect theory explains the behaviour of inexperienced traders more accurately. In a follow-up paper, List (2004) finds that experienced traders in one market, dealing in the sports memorabilia, also behave according to neoclassical theory for everyday consumable goods while support for prospect theory was again found among inexperienced traders.

⁷ Li and Hensher (2011) argue, based on a recent literature review of empirical papers, that prospect theory should be considered in traveller behaviour studies.

travel or access time (Hess 2008), the applications using choice experiments are scarce (e.g. Lanz et al. 2010 address and confirm this asymmetry in water services). Therefore on balance, the results are mixed since some studies, especially laboratory experiments and choice experiments, have found evidence of the existence of prospect theory to explain choices, while others have found the opposite e.g. List (2003; 2004).

In the case of choice experiments, the increase in price from the current level represents the loss in prospect theory terminology, as people have to pay more for electricity than what they are currently paying, while a decrease from current price level represents the gain. This has direct implication on the marginal WTP given that the marginal utility for the non-market attribute is unaffected by price change in a choice experiment study. The marginal WTP for an attribute in a choice experiment is expressed, if we assume a linear in attribute utility function, as the ratio between the marginal utility of the attribute and the marginal utility of income. If the marginal utility of income is affected by price change as predicted by prospect theory, then the increase in price would result in a larger marginal utility of income compared to a decrease. Therefore, the marginal WTP is lower for the same attribute if the price is expressed as an increase from the initial level compared to a decrease.

A second key objective of this paper is to explore the impact of excluding the price attribute altogether from the choice experiment. In some cases the price is not a relevant attribute since it is already decided that a change will take place (regardless of the price), or for a given cost of the project, the focus is on the optimal combination of attributes, in which case the policy of interest relates to obtain the MRSs between non-monetary attributes in order to compare the impact of different projects. For example,

Aas et al., (2000) and Wattage et al. (2005) use choice experiment methodology to study preferences for different fisheries management programs in Norway and the UK respectively by studying the relative importance of diverse (non-monetary) attributes. Another example is Casey et al (2008), which use attributes, such as better opportunities for education and health care, to evaluate the willingness to accept risk for different spill risk scenarios in indigenous communities in Brazil. Thus, it is enough to use the information on MRS to investigate the combination of attribute levels that maximizes the social welfare (or minimize the disutility) conditional on the fact that a project will be implemented. In such case, we investigate the effect on marginal values, i.e., MRSs, of excluding the price attribute from the set of descriptors of the alternatives used in the choice experiment. We do so by comparing the results to the standard case where it is included. It has been shown that preferences measured by choices in the presence and absence of prices differ (e.g., List, 2002; Slovic and Lichtenstein, 1983; Tversky and Thaler, 1990). In a recent study, Carlsson et al. (2007) compare the results from choice experiments with and without the price vector in exploring preferences for food products. They find that preferences were affected by the inclusion of a price vector and more specifically that the MRSs between attributes are lower when a price vector is included. We extend their analysis by investigating the effect on MRS of excluding a price vector from the choice experiment compared to the cases where there is an increase or a decrease in price from the current level. To this end, we use a sample of respondents who faced a choice task without the price attribute, but to ensure complete comparability between treatments we use the same experimental design used in the cases where the price level is included.

Our research questions are explored with choice experiments on the introduction of wind power plants in various types of location in Chile. We use a split sample design where subjects were allocated either to a survey with increased or decreased electricity prices from current level, or no price vector at all. In our application on the construction of future wind farms in Chile, the future generation cost and design of policy instruments used by policy-makers are genuinely uncertain, and thus make our research design credible.

The rest of the paper is organized as follows. In Section 2, we present the policy context; describe the design of our choice experiment study and the econometric model. Section 3 reports the obtained results and the discussion of findings. Finally, Section 4 concludes the paper.

2. The policy context and the choice experiment

To investigate the effect of the different directions of proposed changes in the price vector, as well as that of exclusion of prices on the marginal WTP and MRS estimates, a tailor-made study on preferences for different wind farms in Chile was conducted. The trend in electricity demand in Chile has been characterized by a steady increase, with a forecast annual growth rate of 6% over the coming years.⁸ This forecast has put pressure on how the authorities should best meet the increasing demand, given that Chile has ratified the Kyoto Protocol. The current energy policy is focused on the development of non-conventional renewable energy sources, where wind power is the

⁸ Operation Statistics 1999/2008. CDEC-SIC – Centro de Despacho Económico de Carga (Economic Center of Charge Service). Available at: <http://www.cdec-sic.cl> and www.cne.cl. This page was accessed in March, 2013.

principal option.⁹ Our choice experiment is concerned with the introduction of wind power in southern Chile (VIII Region) as an alternative renewable energy source to the country.^{10,11.}

Since the effect on prices from the newly established wind farms is uncertain, it is both relevant and credible to allow for both increases and decreases in electricity price.¹² In order to study the direction of the price change on marginal values, we investigate the effect of an increase and a decrease in the price vector using a study on preferences for wind farms, which differed in several attributes such as location and size. The payment vehicle used in our study is the monthly electricity bill. The study was conducted in Concepcion, the second largest city in Chile, capital of the VIII Region, and one of the major metropolitan areas that would benefit from the electricity generated by the wind farms.

⁹ In Chile, renewable energy sources are classified into two categories: conventional and non-conventional. Large scale hydropower projects are considered *conventional* sources while the development of wind, solar, biomass, wave, geothermal power and small-scale hydropower are considered *non-conventional*.

¹⁰ Chile consists of 15 regions numbered from north to south and generates its electricity using fossil fuels and hydropower as traditional sources.

¹¹ An important issue to consider when introducing wind power generation to the grid is the intermittency of this source and the energy security. In the case of Chile, low wind power generation would be supplied by other renewable sources such as hydroelectric and thermoelectric according to the merit order list. This study is focused only on the environmental impacts of wind farms. The consideration of effective energy generation and variation of supply capacity is assumed fixed. In order to consider the intermittency of wind power production, further research that introduces demand side management and optimization of generation mix in a choice experiment context is needed.

¹² Previous studies on levelised costs of energy believe that it is more likely that prices will increase (e.g., Grant et al., 2011) due to the high investment and subsidy levels. However, literature on renewable energy suggests that prices would decrease (Di Cosmo and Malaguzzi Valeri, 2012; EWEA, 2010; Sensfuss et al., 2008; Woo et al., 2011) due to in a merit order model, where wind is considered to have a zero marginal cost, wind power would displace thermoelectric power and in consequence reduce spot prices. At the time of design and administration of the survey the Chilean authorities were in the process of designing the policy instruments to boost renewable energy, mainly wind power. A system of free toll was implemented recently and currently the debate on how to subsidize wind power is in the political and environmental agendas. However, it remains uncertain the size of the subsidy this source will enjoy and therefore the final effect on the electricity price. In the case of the Republic of Ireland, which energy situation could in some extent be compared with Chile, O'Mahoney and Denny (2011) have studied the introduction of subsidies to wind-generated electricity in Ireland finding that the value of wind to the market dispatch resulted in savings instead of higher costs.

The Choice experiment methodology is based on the Lancasterian approach and assumes that individual n derives utility from the attributes or characteristics of the good, instead of directly from the good itself (Lancaster, 1966). Following the random utility theory (McFadden, 1974), we assume that individual's n utility function for alternative i , denoted U_{ni} , is composed of two elements. The first of which (V_{ni}) is observable by the analyst, while the second element, ε_{ni} , is unobservable and it is assumed to behave stochastically according to an i.i.d. process as follows

$$U_{ni} = V_{ni} + \varepsilon_{ni} . \quad (1)$$

We assume a linear in the parameters utility function, thus the deterministic part can be expressed as

$$V_{ni} = \beta_n' x_{ni} + \gamma_n c_{ni} , \quad (2)$$

where β_n is the parameters vector corresponding to the non-monetary attributes for the individual n ; x_{ni} is a vector representing the non-monetary attributes, γ_n is the parameter corresponding to the monetary attribute (price attribute) and c_{ni} represents the price attribute of alternative i as faced by individual n . In a choice experiment respondents are presented with repeated choice tasks with two or more alternatives, described by attributes and their levels. Respondents are assumed to choose the alternative that gives them the highest utility and in doing so they reveal their preferences. In our study, choice sets were composed of two generic alternatives described as wind farm projects. Individuals were asked to choose their preferred alternative among the two projects.

Our choice experiment was developed through a series of focus group studies with representatives from both the general public and the energy sector, followed by pilot studies in Concepcion. The scenario preceding the presentation of the choice tasks to the

respondent described the current situation of energy generation in Chile and was followed by a description of the forecasted increase in electricity demand in the near future. Respondents were informed that one way to meet the increased electricity demand is by building wind farms. The scenario included information regarding the environmental benefits of wind farms over thermoelectric sources (e.g. energy is generated without pollution and the advantage of allowing Chile to reduce the dependency on importing gas from neighbouring countries). The wind farms in our choice experiment are described by three attributes besides the monetary attribute: (i) location, (ii) total area covered and (iii) fractions of birds being killed or injured.¹³ These attributes were described in terms of levels: Wind farms can be located in four different places; off-shore, along the coast, on-shore and in the mountains.¹⁴ The total area covered can either be equivalent to 300, 500 or 800 football pitches.¹⁵ The percentage of birds that can be hurt or die each year in the area where wind farms are located was presented as three levels: 1%, 3% or 5% of the bird population. It was clearly stated in the scenario that the projects presented in the alternatives did not differ

¹³ Results from focus groups and the first pilot study showed that attributes such as height of the windmill and noise were not important to respondents, therefore they were not considered in our design. On the other hand, recent studies (Ek, 2006; Meyerhoff et al., 2010; Meyerhoff 2011) have shown non-significant estimates for turbine height attribute.

¹⁴ In our study we use broad classifications of levels in the location attribute without being specific. In the case of how far an off-shore wind farm would be located from the coastline, it is reasonable to assume that respondents thought it would be fairly close to the coastline since the Chilean Pacific sea bottom is characterized for being very deep very close to the coastline. Thus, this would mean that the wind farm could easily been seen from shore. It should be noted that there were no wind farms development in Chile at the time of the survey and thus no information on what distances from the shore wind farms can be located was actually available. The only information available at the time of conduction of this study was that the bottom of the sea in the Pacific coast of Chile is very deep and it would make it financially and technically impossible the installation of off-shore wind farms at large distances from the coastline.

¹⁵ The selection of attributes and design of wind farms was done with electrical engineers working in the wind power sector in Chile. Wind farms are located in a “zig-zag” pattern for efficient use of the wind. The maximum, medium and minimum separation distance technically needed between windmills was used. This distance corresponds to 3, 4 and 5 blade diameters of separation when located one beside the other, and 5, 7 and 9 when windmills are lined up in front of each other. Wind farms were designed to have 30 windmills producing a total of 60MW of electricity (installed capacity). Example of calculation of attribute level of 300 football pitches: 2 rows of 15 windmills. Length: $(15 \text{ windmills} * 70 \text{ meters of diameter}) + (14 \text{ spaces between windmills} * 3 \text{ blade diameters} * 70 \text{ meters}) = 3,990 \text{ meters}$. Width: $(2 \text{ windmill rows} * 10 \text{ meters windmill width}) + (5 \text{ blade diameters} * 70 \text{ meters}) = 370 \text{ meters}$. Total area: $3,990 * 370 = 1,476,300 \text{ square meters}$. Dividing by 5,000 meters of a typical Chilean football pitch area we have $1,476,300 / 5,000 = 295 \text{ football pitches}$, which was presented as 300 football pitches.

in any other aspects apart from those mentioned, e.g. the same amount of electricity would be produced with the same amount of windmills for all wind power projects. The monetary attribute considered a change in the fixed component of the monthly electricity bill, since if the variable part was affected, i.e., price per kWh, it might have a confounding effect because the amount of electricity consumed might then also be changed in response to the price variation. At the time of the survey, the fixed part of an electricity bill in Concepcion was 990 Chilean pesos (CLP).¹⁶ We considered four levels of changes in price ranging between 100 and 900 CLP in our design. Table 1 shows the attributes and levels used in our choice experiment.

Three different split samples were used in our choice experiment; (i) increased price, (ii) decreased price and (iii) no price change (exclusion of price vector). Thus, each subject only received choice sets with either an increase in prices, a decrease in prices or no prices at all. The choice sets presented to respondents were based on a full factorial design from which we created 36 choice sets by using cyclical design (see Bunch et al., 1996).¹⁷ By blocking the choice sets into three groups, each respondent was assigned 12 choice sets. Based on the design for the increased price vector, we created the design for the decreased price vector, substituting the increased price level by the corresponding decreased one, using exactly the same experimental design. We made sure that the difference in price between the two alternatives in a choice set remained the same. Moreover, in order to follow the same experimental design and to make the two treatments comparable, the decrease in the price vector was allocated in

¹⁶ At the time of the survey 1USD = 523 CLP, and a household in Concepción spent monthly on average 12,000 CLP monthly on electricity.

¹⁷ The cyclical design builds on the orthogonal design, where each alternative from a fractional factorial design is allocated to a choice set. Then the other alternative in each choice set is created by cyclical adding next level until the highest level is attained, where then the lowest value is included.

the same interval as for the increase.¹⁸ The price attribute was eliminated from the previous design in order to obtain the design for the subsample excluding the price vector. An example of a choice set used in the study is shown in Figure 1. Face-to-face interviews were conducted at households in the metropolitan area of Concepcion. We used a stratified sampling procedure where we divided Concepcion in strata. In each treatment, we aimed at 102 responses, i.e., 306 completed questionnaires in total, and in each strata we randomly selected the number of households that corresponded to the proportion of household living in that strata in Concepcion. In case the selected household could not be interviewed, this was replaced by the household next door. 26 of the originally selected households were replaced since nobody was at home, while additional 14 households were replaced due to refusal to participate where we interviewed only respondents who were responsible for paying the electricity bill in the household.

>>> Table 1

>>> Figure 1

In the analysis of the responses, we apply a random parameter logit approach (RPL) (e.g. Train, 2003; Hensher and Greene, 2003) in order to consider unobserved heterogeneity associated with respondents' choices, where the error term is assumed to be i.i.d. type I extreme value. In the RPL model, the utility parameters vary over

¹⁸ Given that the fixed charge of electricity was 990 CLP, the price reduction could not exceed that amount; otherwise it will mean that the electrical company should pay to the household, which is not a realistic situation. Therefore, in order to make it comparable, the increase in price vector should also be in the interval (0, 990).

respondents rather than being fixed as it is instead assumed in the multinomial logit model.

For all non-monetary attributes the individual taste parameter, β_n , is assumed to be random and follow a Normal distribution, for which we estimate the mean and standard deviation from the observed data. While we assume the parameters of the attributes vary among respondents, we use a panel structure so that they are assumed constant across choice occasions by the same respondent. We denote the single choice occasion with t . Thus, the logit probability of the sequence of T choices made by individual n (y_n) can be generically denoted by $y_n = (y_{nt=y_{n1}}, \dots, y_{nt=T})$ and is given by the following expression:

$$P_{ni} = \int \left(\prod_{t=1}^T \frac{\exp(\beta_n' x_{nit} + \gamma_n c_{nit})}{\sum_j \exp(\beta_n' x_{njt} + \gamma_n c_{njt})} \right) f(\beta) d\beta. \quad \forall j \neq i \quad (3)$$

Since the integral in equation (3) cannot be evaluated analytically, we have to rely on simulation to approximate it. In this case, we simulate the integral using 500 Halton draws.

Using the parameter estimates of each attribute and assuming a linear utility function, we calculate the marginal WTP and MRS for each attribute. The MRS between non-monetary attributes $k=1$ and $k=2$ is calculated as follows

$$MRS_{k_{1,2}} = \frac{\frac{\partial V}{\partial x_{k=1}}}{\frac{\partial V}{\partial x_{k=2}}} = \frac{\beta_{x_{k=1}}}{\beta_{x_{k=2}}}, \quad k = 1, 2, \dots, m \quad (4)$$

where m is the number of non-monetary attributes included in the choice experiment. Similarly, the marginal WTP is given by

$$WTP_k = \frac{\frac{\partial V}{\partial x_k}}{\frac{\partial V}{\partial c}} = \frac{\beta_{x_k}}{\gamma} . \quad k = 1, 2, \dots, m \quad (5)$$

Let us now explore the differences between standard neoclassical theory and prospect theory. In the case of prospect theory, we expect the marginal utility of income to vary by the direction of the price change. For simplicity, we estimate one model for price increase from today's level and another for decrease in price using Equation 3.¹⁹ Thus, according to prospect theory, we expect a higher marginal utility of income when there is a price increase compared to a price decrease, i.e., $\gamma^+ > \gamma^-$.²⁰ Thus, we predict the following relationship for a price change of attribute k and for marginal WTP of the attribute k

$$WTP_k^+ = \frac{\hat{\beta}_{x_k}}{\hat{\gamma}^+} < \frac{\hat{\beta}_{x_k}}{\hat{\gamma}^-} = WTP_k^- . \quad (6)$$

In other words, in case of prospect theory, we expect a larger WTP estimate when the price decreases from today's price level compared to an increase in price. Moreover, neoclassical theory predicts no differences in the marginal utility of income, i.e.,

¹⁹ We could also have estimated them jointly, but we prefer to have separate regressions since we also compare to the case where price is excluded.

²⁰ In choice experiments, the estimated parameters from different models cannot be directly compared due to the scale parameter.

$\gamma^+ = \gamma^-$, therefore we expect equality between the two WTPs, i.e., $WTP_k^+ = WTP_k^-$. It should be noted that we do not expect the estimates for MRS to be affected by the direction of a price change (since only the marginal utility of income is affected).

With the random parameter model, the panel nature of the data allows us to retrieve individual-level parameters using Bayes' theorem (e.g. Train, 2003; Revelt and Train, 2000; Greene et al., 2005) and using these parameters in the calculation of the individual marginal values for respondents in our samples. With the distributions of individual-specific estimates of MRS and marginal WTP from the subsamples, we extend the set of comparisons of the effects of price vector treatments beyond the classic point estimates based on population moments.

3. Results and discussion

In Table 2, we report the results of the estimations from the random parameter logit models for each of the three sub-samples; increased, decreased and no price vector, respectively. The standard deviations of all random parameters are significant in the three sub-samples providing evidence of unobserved heterogeneity in preferences among respondents. In order to evaluate the respective model fits we present the log-likelihood values and the Bayesian information criterion (BIC) to enable model comparisons as the models have different number of parameters. The results show that the model which has the best fit is the one that excludes the price vector. This is not surprising since a lower set of attributes decreases the cognitive effort faced by respondents, which is in turn related to random utility variance. The estimated

parameters are significant in all cases at the 1% level and the variables Birds, Area Covered and Price have the expected negative sign, indicating that these impacts (more birds killed, larger area covered by wind farms and a higher price or lower discount) negatively affect individuals' utility. Among the dummy variables representing location, off-shore location, which is the baseline, emerges as the most preferable location across all models since the coefficients representing the other locations are negative. However, the most disliked location differs across treatments. While coast location is the most disliked in both the treatment including an increased price vector and the exclusion of the monetary attribute, in the model with a decreased price vector the least liked location is in the mountains. However, only in the model excluding the price vector are the differences statistically significant.

>>> Table 2

Table 3 presents the estimates of the population means for the marginal WTPs and the estimated MRSs of all attributes computed with respect to Area Covered. We begin to investigate whether the direction of price change influences the estimated marginal WTP, as if they do, then there is corroborating evidence for prospect theory. The marginal WTP is higher for the decreased price vector which supports evidence of prospect theory for the attributes representing the loss of birds and area covered. We test the null hypothesis implied by neoclassical theory, i.e., that the marginal value are the same between an increase and a decrease in the price. By comparing the confidence intervals, the only statistically significant difference found is for the loss of birds

attribute. For all the other attributes, the confidence intervals of each calculated marginal WTP overlap for the two directions of price changes. Since this is a conservative test, other test based on combinatorial would also reject the null. Thus, our direction of change in the price attribute does not seem to influence the marginal WTP and support the neoclassical theory. However, the confidence intervals for the model with the decreased price vector are generally larger. In the case of the MRSs, all confidence intervals overlap except for one case – the Mountain Location attribute is different in the model with increased price vector compared to the one without. These findings are as expected based on the discussion in Section 2 that the marginal utility of non-monetary attributes should be unaffected by changes in the direction of price from its initial level.

>>> Table 3

Most choice experiment studies only report estimates of population mean values. However, distributions of conditional welfare estimates within the sample are important when policy-makers are concerned with equity issues and this represents a further dimension of appraisal in policy analysis (e.g., Scarpa and Thiene, 2005). In Figure 2, we compare the plots of the kernel density distributions of marginal WTPs individual-specific estimates, which were retrieved using the Bayes' Theorem. In the sub-sample with decreased prices, the conditional means of the individual specific marginal WTP distributions for location attributes are slightly left-shifted with respect to those obtained from the treatment with increased price vector. The opposite effect occurs for the attributes representing the loss of Birds and Area Covered, with a particularly marked

shift for Birds. A remarkable difference is noted for the case of the attribute Area Covered (the last distribution shown at the bottom of Figure 2), where the dispersion of the marginal WTP is much higher in the sub-sample with the decreased prices. In general the shapes of distributions associated with an increased price vector are slightly more leptokurtic (peaked) around the mode, except for Mountain Location. With the exception of Birds, the modal estimates seem to be very close across sub-samples, thereby suggesting robustness of the modal estimates for four out of five attributes. Table 4 shows the results from the Mann-Whitney U-test of the null hypothesis of no difference in the distribution of estimated individual-specific marginal values between the different treatments. There are five pair-wise tests for the marginal WTP and the null hypothesis of no difference is rejected in two cases (Birds and Area Covered) at the 5% significance level. Overall, it seems that the direction of change in price also affects the spread of individual marginal WTP differently.

>>> Figure 2

>>> Table 4

Figure 3 shows similar plots of kernel distributions for conditional means of the individual-specific MRSs between the non-monetary attributes (Area Covered was used in the denominator) across all three price attribute treatments and models. In this case, the sample with no price vector shows a more leptokurtic distribution with a lower variance than the other sub-samples, except for the location attribute along the Coast. However, the overall model estimates are very similar, thereby showing that the

calculated MRSs are robust to inclusion or exclusion of a price vector. For the MRS distributions, there are 12 pair-wise tests between the non-monetary attributes respectively for the null hypothesis of equality. Results of the Mann-Whitney U-test are showed in Table 4. The null hypothesis of equal distributions is rejected in 6 out of 12 cases at the 5% confidence level, indicating the presence of differences. Therefore, despite the conclusion that calculated means of MRSs and marginal WTPs tend not to have significant difference across models at the actual level (derived from the sample estimates), we reject the null of identical distributions of individual specific estimates in several cases. We conclude that there are some differences, but they concern sample statistics other than the means (i.e. variance and quintiles). This is interesting as it may have consequences in policy advice that depend on distributional issues and equity.

>>> Figure 3

4. Conclusions

The overall objective of this study was to investigate the effect of the direction of change in price, expressed either as an increase or decrease from current price level, or exclusion of the price vector on the marginal values and distribution of their individual specific estimates in a choice experiment. The former is of interest in many areas including the energy sector since the direction of changes in electricity prices after, for example, the introduction of new technologies such as wind power or other renewable energy sources, is often uncertain. The latter part refers to the case when the objective is to compare different alternatives conditional on the fact that a change would take place

and hence, substitution patterns are of interest.

We relate our first objective to prospect theory (Kahneman and Tversky, 1979; Tversky and Kahneman, 1991) and investigate whether changes in price from the reference point, which in our case is assumed to be the current electricity price level, result in disparities in marginal WTP estimates; or whether on the other hand, there are no differences and thus the reference price is not relevant, as postulated in standard neoclassical theory and supported empirically among experienced people in List (2003, 2004). Using a split sample approach, we studied the impact of the introduction of a monetary attribute (price) defined as either an increase or decrease in the price level from the current level as well as the exclusion of the monetary attribute on marginal values in separate sub-sample treatments. The research was applied to the construction of wind farms in the Central Chile. Results showed that there are no significant differences in most of the marginal WTP between the different treatments. By and large, the direction of change in the price vector does not seem to affect marginal WTP. In terms of the prospect theory, this means that there are no disparities in WTP values, i.e. in general individuals value gains and losses expressed as price changes from current level equally, and therefore we find more support to neoclassical theory compared to prospect theory in the case of this study.

On the other hand, we find that the exclusion of the price vector also results in no significant differences in MRS estimates between the non-monetary attributes across treatments. However, model estimates obtained from the experiment without price vector show a better fit and higher efficiency (as indicated by the lower standard errors). In line with other studies, we speculate that a plausible reason for this is the lower cognitive burden on respondents (so that they have to evaluate less information in the

choice experiments, reducing task complexity) (Caussade et al. 2005), or a lower incentive to engage in strategic behavior (Hensher, 2006).

To enrich the policy discussion, we also explored the effects of price vector exclusion and direction of change in price (either increase or decrease) on the distributions of individual specific estimates obtained conditionally on the observed pattern of response for each single respondent (e.g., Greene et al., 2005; Von Haefen, 2003). We find statistically significant differences in the distributions of individual specific (conditional) means of marginal WTP and MRS across price treatments. We find less leptokurtic (peaked) distributions of marginal values when the price decreases, indicating that a higher proportion of respondents have relatively more extreme marginal values. One potential explanation for this may be found in the search theory (e.g., Stigler, 1961), where individuals “search” or make an effort until the marginal cost of this effort is equal to the marginal benefit from the effort made by them; e.g., when goods get cheaper individuals would spend less effort in choosing. In the case of increased price from current level, subjects spend more time considering the choices, resulting in less variance in marginal values. This change in the higher moments of the distribution may have important consequences in policy design when equality is an objective. We hence argue that this should be further explored in future research.

Finally, for a policy maker’s perspective, the results show that households have concerns about the environmental impacts of wind power, which is evident from their preferences for off-shore wind farms versus the other locations, in particular along coastal areas. They also consider, on average, the impacts of wind farms included in this study as negative and important in all the cases, independent of the direction of the change in the price.

Altogether our results show that the mean estimates of the marginal values are robust to price vector inclusion and direction of the price change. In terms of future research, this should focus on the more general question related to exploring how the reference price matters in the case of valuation of non-market goods using choice experiment, and how increased experience might influence the importance of direction of the price change. In the context of energy policies this is particularly important in the valuation of newer and less well-known sources of energy generation such as wave or tidal power or the usage of electric vehicles. Future research is also needed to understand the reason for differences in distributions of individually retrieved marginal values in relation to the reference price. In general, more concrete knowledge about whether reference price matter is needed to instill confidence when using the results from choice experiments to inform policy in cases when a priori uncertainty exists about the direction of price changes.

Acknowledgments: Financial support from Swedish International Development Cooperation Agency (Sida) to the Environmental Economics Unit at University of Gothenburg and from the Swedish Research Council (*Vetenskapsrådet*), from Formas through the program Human Cooperation to Manage Natural Resources (COMMONS) is gratefully acknowledged. We thank Fredrik Carlsson, George Hutchinson, Edel Doherty, Laura Malaguzzi Valeri and Claudio Roa for helpful comments.

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Table 1. Attributes and Levels used in the Choice Experiment Design.

Attributes	Levels
Location	Off Shore
	On Shore
	Along the Coast
	In Mountains
Birds	1%
	3%
	5%
Area Covered	300 Football pitches
	500 Football pitches
	800 Football pitches
Price (Increased Price Vector)	100
	300
	600
	900
Price (Decreased Price Vector)	-100
	-400
	-700
	-900

Table 2. Random parameter logit model estimates (t-values in parentheses).

	Increased Price Vector		Decreased Price Vector		No Price Vector	
	Mean	Parameter	Mean	Parameter	Mean	Parameter
	Parameter	St	Parameter	St	Parameter	St
	Estimate	Deviations	Estimate	Deviations	Estimate	Deviations
On Shore	-0.47	1.48	-0.35	1.56	-1.04	1.98
	(4.92)	(10.62)	(3.30)	(9.89)	(8.30)	(10.51)
Mountain	-0.59	1.47	-0.38	1.41	-0.51	1.90
	(5.64)	(9.84)	(3.51)	(9.39)	(4.07)	(10.45)
Coast	-0.66	1.30	-0.37	1.23	-1.15	2.81
	(5.79)	(9.54)	(3.05)	(8.62)	(7.58)	(11.77)
Birds (%)	-0.37	0.68	-0.54	0.68	-0.71	0.99
	(14.05)	(14.11)	(16.35)	(13.63)	(15.51)	(13.67)
Area covered	-0.10	0.14	-0.14	0.32	-0.29	0.46
	(5.67)	(5.48)	(7.44)	(11.01)	(11.34)	(11.28)
Price (×100)	-0.0013	(fixed)	-0.0010	(fixed)	-	-
	(12.82)		(8.46)			
Log-likelihood	-628.53		-595.81		-538.17	
function						
BIC ^a	1307.96		1242.50		1122.59	
Number of						
Observations	1224		1224		1224	

^a Bayesian Information Criterion

Table 3. Mean marginal WTP and MRS between attributes. (95% Confidence interval in parenthesis).

	Marginal WTP	Marginal WTP	MRS	MRS	MRS
	Increased Price	Decreased Price	Increased	Decreased	No Price
	Vector ^a	Vector ^a	Price	Price	Vector
			Vector	Vector	
On Shore	-367.12 (-522.81;-211.42)	-340.53 (-559.28;-121.78)	-4.59 (-6.96;-2.23)	-2.42 (-4.00;-0.84)	-3.60 (-4.56;-2.54)
Mountain	-454.77 (-615.25;-284.29)	-373.06 (-585.62;-160.49)	-5.69 (-8.25;-3.13)	-2.65 (-4.20;-1.11)	-1.76 (-2.63;-0.89)
Coast	-509.16 (-693.76;-324.56)	-367.01 (-619.56;-114.45)	-6.37 (-9.31;-3.43)	-2.61 (-4.42;-0.80)	-3.96 (-5.09;-2.83)
Birds	-288.12 (-339.81;-236.43)	-527.30 (-645.83;-408.77)	-3.61 (-4.87;-2.34)	-3.75 (-4.72;-2.78)	-2.45 (-2.83;-2.07)
Area covered	-79.91 (-108.89;-50.94)	-140.54 (-187.50;-93.58)	-	-	-

^a Figures of marginal WTP in Chilean pesos.

Table 4. Result of Mann-Whitney U-test (p-values).

Hypotheses	On Shore	Mountain	Coast	Birds	Area covered
Marginal WTP_i	0.357	0.186	0.052	<0.001	0.001
decreased price = increased price					
MRS_i decreased price = increased price.	0.003	<0.001	<0.001	0.130	n.a.
MRS_i decreased price = no price	0.008	0.462	0.160	0.732	n.a.
MRS_i increased. price = no price	0.444	<0.001	0.023	0.344	n.a.

Figure 1. Example of a choice set.

Attribute	PROJECT A	PROJECT B
LOCATION	On Mountains	On the coast
BIRDS	1% of the birds are hurt or die	3% of the birds are hurt or die
AREA COVERED	800 Football Pitches	300 Football Pitches
PRICE	\$ 300	\$ 600
Your choice	_____	_____

Note. Price expressed in Chilean pesos.

Figure 2. Kernel density plots of marginal WTP_i .

(Continuous line shows increased prices and dashed line the decreased prices from current level).

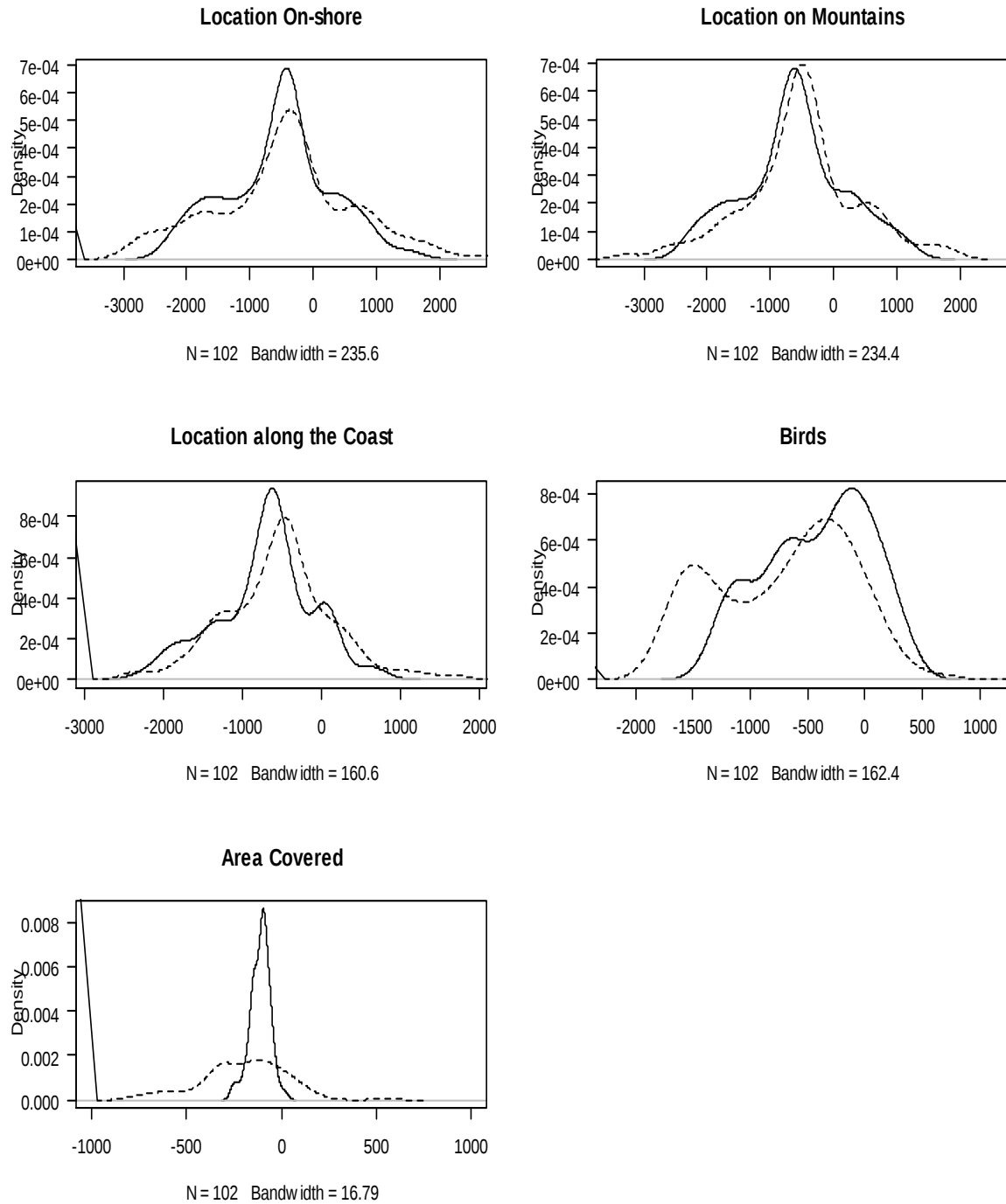


Figure 3. Kernel density plots of MRS_i with respect to attribute area covered. (Continuous line shows increased price vector, dashed line decreased price vector and dashed-dotted line no price vector).

