Tax or no tax?

Preferences for climate policy attributes*

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Abstract

Today, many countries around the world respond to the global warming and its consequences with various policy instruments such as e.g. taxes, subsidies, emission permit trading, regulations and information campaigns. In the economic literature, policy instruments have typically been analyzed with respect to efficiency, while little effort has been put on public preferences for these instruments. In this paper, an Internet-based choice experiment is conducted where respondents are asked to choose between two alternative policy instruments that both reduce the emissions of CO_2 by the same amount. The policy instruments are characterized by a number of attributes; a technology-effect, an awareness-effect, cost distribution, geographic distribution and private cost (presented in more detail in the paper). By varying the levels of each of the attributes, respondents indirectly reveal their preferences for these attributes. Half of the respondents are faced with instruments labeled by 'tax' and 'other', whereas the other half are faced with unlabeled instruments. As for the label, the results show that people dislike the 'tax'. The results also show that people prefer instruments with a positive effect on environmentally-friendly technology and climate awareness. A progressive-like cost distribution is preferred to a regressive cost distribution, and the private cost is negatively related to the choice. Finally, the results indicate that Swedes want the reduction to take place in Europe but not necessarily in Sweden.

Keywords: preferences; climate policy measures; choice experiment; web-survey

JEL classification: H20; H31; Q48; Q50

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1. Introduction

The will to reduce greenhouse gases may take its expression in a variety of ways. As an economist, you would perhaps suggest taxes, subsidies and emissions permit trading as appropriate tools for reducing greenhouse gases. However, lately we have seen other, perhaps more 'non-standard', ideas on how to reduce greenhouse gases such as CO_2. One example is the European law against light bulbs to make way for other less energy consuming lights. Another example is the Californian proposal of banning black cars because of their color. The California Air Resources Board argues that the climate control systems of dark colored cars need to work harder, and thereby consume more gasoline than their lighter siblings. An economist would most likely object to the suggestions above and argue that it is more efficient to hit the source directly (e.g. with a CO_2 tax), since it is not the light bulb or the color themselves that causes the problem. So, given the variety of climate policy instruments available, which one should be selected to reduce CO_2? Are there reasons for not using the, from an economic perspective, most efficient instruments available? What are the public's preferences for attributes characterizing climate policy instruments?

Today, many countries have pledged to reduce their emissions of greenhouse gases (primarily CO_2)[1]. Among these countries, Sweden started with corrective environmental taxes in 1991 (carbon-, electricity- and sulfur taxes). In the Swedish case, the aim was not only to reduce greenhouse gases, but also to reduce the levels of distortionary income taxes already contained in the tax system[2]. At the European level, emissions permit trading is at current use while a similar system, the cap and trade program is suggested in the US. Examples of other climate policy instruments at disposal for a decision maker are of course regulations, information campaigns, subsidies etc. However, as indicated above, the perhaps most straightforward approach from an economic perspective is to look for the most cost efficient policy instrument available – meaning that a carbon tax or an emissions permit trading system will be some of the most preferred alternatives (market-based policies).[3] Why is it then the case that policy-makers often choose alternatives that obviously are not the most 'cost efficient'? Of course, one reason may be that the instrument does not reflect the political view

[1] For example, according to the Kyoto protocol Annex I countries need to reduce their collective emissions of GHGs by 5.2% compared to the 1990 levels by the year 2012.

[2] See e.g. Brännlund and Kriström (1999), Brännlund and Nordström (2004).

[3] Traditionally, emission taxes and permit trading are both market-based approaches to reduce pollution; see e.g. Baumol et al (1988) and Dales (1968), Montgomery (1972), Thomas H. Tietenberg (1980), respectively. See also a paper by Muller and Mendelsohn (2009) for a discussion on efficient pollution regulation.

of the incumbent government. Another reason may be that there is some more or less obvious disutility attached to the instrument itself. In the decision process, it is important to consider not only economic efficiency but also public preferences toward the suggested instruments. Specifically, policies that reflect public preferences are more likely to become efficient in practice. Although policies are cost efficient, it may lead to more tax avoidance and votes for sending the incumbent government out of office. The purpose of the present paper is to explore public preferences for attributes characterizing climate policy instruments, which then give valuable insights for future policies concerning the tradeoffs between pure cost efficiency and public acceptance.

There are previous studies trying to explore peoples' preferences for climate policy measures. Hammar and Jagers (2002) find that Swedish citizens prefer subsidies to encourage the use of environmentally friendly goods, instead of a tax on environmentally bad goods. An important drawback with their study is that they did not make clear that a subsidy imposes a cost to the government and, in the end, households. Bannon et al (2007) explores preferences for specific climate policies while also taking into account the cost imposed to the society. Specifically, they studied Americans' preferences for a regulation, an emissions tax and an emissions permit trading system, respectively. Respondents were told that emissions of greenhouse gases should be reduced and their job was to choose the preferred alternative. In the survey, the reduction was held constant while the costs of the respective policy instrument varied. Their results indicate that Americans prefer rules and regulations before taxes and emissions permit systems.

The purpose of this paper is to extend the literature in primarily two ways. First, we aim for a better understanding of public preferences toward different climate policy measures. This is pursued through a choice experiment (CE) where the respondents are asked to choose between climate policy measures characterized by a number of attributes (to be presented in the next section), while accounting for the respondents budget constraint. Each respondent is faced with repeated CE questions where the attribute levels are varied between each choice set. Hence, by varying the attribute levels we observe each attribute's influence on the choice of policy measure. A cost attribute is included as one of the attributes, meaning that we are able to attach a monetary value to the trade-off respondents make in their decision. Account is also taken to possible stigma effects from the labels attached to specific policy measures. Therefore, half of the sample faces a choice between generic policy instruments (labeled A and B), while the other half faces a choice between 'tax' and 'other'. Note that we designed the experiment so that the attributes characterizing the policy instruments (besides the label) varies in the same way for both groups. The second contribution to the existing literature relates to the survey itself. The survey is internet-based and collects information from 2,400 Swedish citizens (see below for a more detailed description of the survey). Web-based surveys are still quite rare and our study therefore gives valuable experience and guidance for future surveys to be conducted on the internet.

The choice experiment approach for investigating people's preferences is becoming more and more common in the economics literature[4]. The main advantage with a CE is that it, at least to some extent, replicates a realistic scenario. Respondents implicitly make trade-offs between the different characteristics while still considering the cost. These trade-offs are typically not captured in the related contingent valuation methods and, therefore, justifies a CE in a setup as ours. The CE approach of course relies on the assumption that respondents are inherently trained for making trade-offs. For scenarios with well-known consumer products, CEs are rather standard and used extensively in the marketing and transportation literature[5]. For example, how important are packaging, brand name and price in the decision process for buying cereals or toothpaste? Unfortunately, the choice between climate policy instruments is much more unfamiliar for the public. But in comparison with other methods, CEs are still the most promising. It should however be mentioned that we do not intend to reflect all possible characteristics of each policy instrument. The important feature is that the chosen attributes (characteristics) are relevant and affect people's decisions.

The outline of the paper is as follows. Section 2 discusses the survey development with its advantages and shortcomings, while also presenting descriptive statics for the sample. The paper then continues with the economic and econometric specification in section 3, while section 4 presents and discusses the empirical results. Finally, section 5 concludes.

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[4]The choice experiment approach has evolved from the Lancaster (1966) theory of value and the random utility theory; see e.g. Hanley et al. (1998).

[5] Designed choice experiments were introduced in the transportation and marketing research by Hensher and Louviere (1982) and Louviere and Woodworth (1983).

2. The Survey

2.1. The choice experiment

The choice experiment concerns a choice between different policy measures characterized by a number of attributes. As indicated in the introduction, we are interested in preferences for each of these attributes. One of the attributes of particular interest is the 'label' attached to policy instruments. Therefore, we have divided the sample so that half of the respondents face a choice between policy instruments A and B (the generic, unlabeled, case), while the other half choose between 'tax' and 'other' (the labeled case).[6] Besides the 'label', the following attributes characterize our policy instruments.

Table 1. Attributes in the survey.

Attribute	Description	Levels
Effect on the development of environmentally-friendly technology.	Policies may affect the willingness to investment in new technologies, which may simplify the reduction of emissions.	▪ Positive effect ▪ Negative effect ▪ No effect
Increased climate 'awareness' among Swedes.	Policies may affect peoples' awareness of how their behavior influences the climate, which may lead to people acting more climate-friendly.	▪ Yes ▪ No
Social distribution of costs.	Reduced emissions of CO_2 impose a cost on society. The cost can be distributed across society in different ways.	▪ All citizens pay the same amount (regressive). ▪ All citizens pay the same share (percentage) of income (neutral). ▪ Higher income citizens pay a larger share (higher percentage) of income (progressive).
Geographic distribution of the reduction in emissions.	Depending on the choice of policy instrument, the given reduction of CO_2 may take place in different regions.	▪ Sweden ▪ Europe (but not Sweden) ▪ Outside Europe
Monthly cost (private) until 2012.	The reduction of CO_2 imposes a cost on society. Since you represent the society, you will face a cost. In some way the cost will occur, although the size depends on the chosen policy.	▪ 100 SEK ▪ 300 SEK ▪ 600 SEK ▪ 1000 SEK

The selection of relevant attributes, and their respective levels, is of course of paramount importance. The way we have selected the attributes is through a process which starts from

[6] See e.g. Blamey et al (2000) for specific issues regarding labeled and unlabeled experiments.

basic ideas about climate policies and their inherent properties.[7] Focus groups were involved both to get an idea of how different selected attributes was perceived, but also to identify attributes that seems important, but for some reason was missed in the first stage. After several focus groups, a pilot study was undertaken[8]. Concerning the design and selection of attributes, the major difference between this study and the pilot study is that the present study has one additional attribute – the geographic distribution of the emissions reduction. This particular attribute was tested in extra focus groups where, as in the initial ones, questionnaires were filled out, discussed in open group discussions, revised and thereafter tested in new focus groups. This type of preparation also serves to find an 'easy to understand' format of the questions and the survey as a whole. The final attributes and their levels are those presented in Table 1.

A fundamental starting point for the survey is that the Swedish parliament has decided to reduce Sweden's emission of greenhouse gases by 4 percent compared to the 1990 level. Specifically, the average emissions of greenhouse gases between 2008 and 2012 must, at least, be 4 percent lower than the 1990 level. Therefore, throughout the questionnaire it is emphasized that each alternative policy measure reduces the emission of CO_2 by exactly 4 percent – independent of the attributes attached to the respective instrument. Note that this assumption also applies to policies where the reduction takes place in several countries – the total reduction is still 4 percent in Swedish numbers. An example of a choice situation is presented in the Appendix.

When respondents make their choices, they implicitly make trade-offs between the attributes attached to each alternative. To estimate each attribute's impact on the choice of instrument, their respective levels need to be varied. In our survey, each respondent faces a number of choice situations (12) where the levels of each attribute varies. The manageable number of choice sets to each individual has been discussed in the literature.[9] Too many sets are problematic since the respondent get tired and may create a habit/routine. In addition, too many choice sets may also imply more non-responders; see Carlsson and Martinsson (2008). On the other hand, too few sets may be problematic since the questions are rather complex

[7] The International Panel on Climate Change identifies the following climate policy measures: Regulations and standards, Price mechanisms (taxes, charges), Price mechanisms (tradable permits), Financial incentives (subsidies), Voluntary agreements, Information instruments, Public R&D.

[8] See Cole and Brännlund (2009) for a more detailed description of the pilot study

[9] See e.g. Hensher et al (2001) and Carlsson and Martinsson (2008) for a discussion on the number of choice sets.

and takes time to understand, meaning that respondents may not answer at all. As for the present survey, each respondent is supposed to manage 12 choice sets, of which the order is randomly drawn.

To make any inference from the study, the number of choice sets and the variation of attribute levels facing each respondent are very important. The design of choice sets follows a process originating from a L^{AC} factorial (a full factorial), where C is the number of alternatives and A the attributes with L levels[10]. The full factorial represents all possible combinations of attributes and attribute-levels, which typically result in an unmanageable amount of choice sets for each respondent to consider. Based on pilot study information about the attributes, we eliminated too dominating alternatives from the full factorial and thereby considered utility balance between alternatives[11]. Having done that, we used a D-optimal procedure (OPTEX) in SAS to create the choice sets; see Kuhfeld (2005). The procedure considers orthogonality, meaning that the variation of the attributes should be uncorrelated within and across each alternative. The assumption of no correlation across alternatives is only necessary for labeled experiments since the label itself may affect the choice. However, to have both split samples facing an identical questionnaire, we decided to use the same experimental design for both groups of respondents. Although our procedure generated a workable design with 21 choice sets, we decided to adjust the design for efficiency reasons and increased the number of choice sets to 24.[12] Moreover, the 24 choice sets were divided into two blocks with 12 choice sets each - each respondent facing one of the blocks. Finally, in addition to the choice experiment part, the questionnaire contained questions regarding the respondents' socio-economic status and other climate-policy related issues.

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[10] Given our setup, this implies a full factorial of $((3^3)(2^1)(4^1))^2$ = 46656 combinations. Note that, with generic alternatives the full factorial only consists of $(3^3)(2^1)(4^1)$ = 216 combinations. The reason for having a full factorial of 46656 in the design process is that we, simultaneously, conducted a labeled experiment.

[11] We used a code-sum technique to eliminate choice sets where one alternative was too dominant. Considering the first, second and last attribute in Table1, choice sets with a maximum difference in code-sums between the respective alternative were eliminated. The reason for only considering three attributes was the information obtained in the pilot study about their respective distribution.

[12] The number of choice sets (24) was determined according to a macro (MktRuns) in SAS suggested by Kuhfeld (2005). The software ranks different designs according to efficiency measures. We decided to choose the first design in this ranking with a reasonable number of choice sets. By comparison with the design suggested from degrees of freedom considerations only, the D-efficiency measure increased from 92,9 to 95,5. See e.g. Street et al (2005) for a discussion regarding efficiency measures and their importance.

2.2. Survey method and sampling

An important feature of our survey is that it is carried out on the internet, i.e. it is a web-based survey. A web-based survey has many advantages by comparison with a standard ‘mail’ survey. Web-surveys are often less costly, more flexible and imply faster data collection. The flexibility regards how you can easily make changes in an already existing survey. For example, if you suddenly realize that something is misunderstood you can correct it and re-start the survey – imagine a mail survey where you need to redo the whole sample selection etc. Regarding flexibility, it is also more convenient to randomize questions, do more complex follow-ups etc. Data collection becomes very easy for a web survey since the data is coded correctly when you receive it. Moreover, there are no drop-outs or ‘blanks’ since it is made technically impossible to skip a question. There are also some potential drawbacks with a web-based survey. The main reason as to why web-based surveys are questioned is that there may be a selection problem – only individuals with access to a computer and internet can be part of the study. However, it is not obvious that such a selection bias will be great in magnitude in all circumstances. The point is that this issue of selection bias must be considered and analyzed in each individual case, since access to computers and internet varies over countries and population groups within countries. Thus, one would expect that the bias of using the internet would be smaller in say Sweden than in a less developed country. In a less developed country a substantial part of the population may not have access to internet continuously, and more importantly, those who have access may not be representative for the population. In Sweden, on the other hand an overwhelming part of the population has continuous access to a computer and internet, and the only significant difference in access and use of internet is between the most elderly people (more than 64 years) and the rest of the population.[13] Nevertheless, it is important to search the sample carefully for possible weaknesses.

2.3. Descriptive statics

For data collection, we employed a company (Norstat) which controls an Internet panel with more than 90,000 pre-recruited respondents in Sweden (fall 2008). The panel differs from many similar panels in the sense that members are recruited randomly by telephone and self-

[13]In 2008 88% of the population, between 16 and 74 years of age, had access to Internet in their home (Statistics Sweden, 2008). Furthermore, 84% of the population (16-74) states that they use Internet at least one time per day (Statistics Sweden, 2008). If we break down these numbers for different groups, concerning age, income, employment, unemployment, etc., the conclusion is that differences are small, except for the most elderly. http://www.scb.se/statistik/_publikationer/IT0102_2008A01_BR_IT01BR0801.pdf.

recruitment is prohibited. Given the panel of 90,000 citizens, Norstat selected a representative sample according to age (18 and older), gender and geographic location. The survey was sent out in February 2009 to a sample of 2,400 Swedish citizens registered in the 'Norstat panel'.[14] Half of the respondents were faced with the labeled choice sets, while the other half were faced with the generic choice sets. In addition to the choice sets, the questionnaire contained one section with basic socio-economic questions while another section contained questions related to climate awareness and individual behavior in general. Table 2 summarizes some of the more interesting descriptive statistics among the 2,400 respondents (both split-samples).

Table 2. Descriptive statics.

	Description	**Mean (st. dev)**	**Percent**	**Swedish population**
Gender	Male		47.5	49.7 (2008)*
Age	Years , 18-	50.47 (15.2)		48.9 (2008)*
Household income (SEK per month)	0-29,999		33.8	mean 32,000
	30,000-79,999		61.6	(2007)*
	80,000 -		4.6	
Households with 2 or more children at home	-18 years old		24.2	16% (2006)*
Households with 2 or more incomes			74.9	
University education			46.5	33%
Commuting habits (work, university, school etc.)	Car/motorcycle		53.3	
	Public transp.		15.5	
	Walk/bicycle		24.9	
	Other		6.3	
Personal 'expertise'	Competent (env. issues)		10.0	
	Politician		2.4	
	Company owner		7.7	
	Other (public)		79.9	
If CO_2 from motor vehicles must be reduced – what would you prefer?	Tax on fossil fuels		9.6	
	Information campaign		53.3	
	Regulations		30.0	
	Increased income tax		7.1	
Do you believe that the current governmental expenditure on env. protection is too low.	Yes		59.2	
How should the cost be distributed?	'Polluter pays'		78.5	
	'Those who afford pay'		7.3	
	'Those who think it's important pay'		3.3	
	'Everyone share the cost equally'		10.9	

* Statistics Sweden, www.scb.se

[14] Specifically, the first sample (2,000 surveys) had an overweight for elderly people, implying an additional sample of 400 'younger' people.

By comparison with the Swedish population, the sample looks quite representative although we have not formally tested for the differences. One obvious difference is however that our sample is more educated (the reason is unknown, although it may be by pure chance). Moreover, answers from some of our climate-policy related questions are potentially very interesting. For example, 59.2 percent believes that current expenditures on environmental protection are too low and an absolute majority thinks that the polluter should pay the reduction of CO_2. It is also worth noting that the direct question regarding which instrument to be used for a reduction of CO_2 corresponds to Hammar and Jagers (2002). That is, without the 'cost-attribute' most respondents prefer information campaigns, followed by the regulations alternative – taxes are not very popular. In our view, the findings above are interesting but to simplistic since they do not reflect real world scenarios. The results from the choice experiment questions work to fill this gap.

3. Econometric specification

The choice-question responses obtained from the questionnaires are primarily analyzed in the random parameter logit (RPL) framework – although results from a standard logit are also presented.[15] One important characteristic of the RPL-model is that it does not exhibit the independence of irrelevant alternatives (IIA) property (well known from the traditional logit model) and that it allows for unobserved heterogeneity; see e.g. Train (2003). We do not here intend to formally derive the RPL model since this has been done in many other studies and, in addition, we follow the standard procedures.[16] However, some basics should be mentioned before we proceed. Let us define the utility experienced by individual q from choosing alternative j in choice situation t as

$$U_{jtq} = \alpha_{jq} + \beta_q X_{jtq} + \varepsilon_{jtq} \qquad (1)$$

where X is the vector of explanatory variables including attributes attached to each of the alternatives. α_{jq} is the alternative specific intercept which allows for an intrinsic preference for the alternative itself (not necessarily applicable for the unlabeled experiment). The unobserved parts of the equation is hence α_{jq}, β_q and ε_{jtq}, which are treated as stochastic.

[15] The RPL-model is also known as the mixed logit, mixed multinomial logit and hybrid logit.

[16] For a more detailed description of the RPL-model, see e.g. Train (2003), Hensher and Green (2001) and Hensher et al. (2005).

Of course, the respondent knows the value of his own α_{jq}, β_q and ε_{jtq} for all *j* and chooses the alternative with the highest utility. In the standard logit context it is assumed that the error term, ε_{jtq}, is independent and identically distributed (IID) extreme value type 1 across individuals as well as across alternatives and choice situations. One way to relax this assumption is to divide the stochastic part into two; one correlated over alternatives and heteroskedastic, the other IID over alternatives and individuals. That is (ignoring the *t* subscript),

$$U_{jq} = \alpha_{jq} + \beta' x_{jq} + \gamma_{jq} + \varepsilon_{jq}, \tag{2}$$

where γ_{jq} is a random term whose distribution over individuals and alternatives depends on underlying parameters and observed data related to each alternative and individual. In principle, γ can take on any distributional form such as normal, lognormal, triangular etc. As long as ε_{jq} is IID type 1 extreme value, we have a random parameter logit model. By denoting the density of γ by $f(\gamma \mid \Omega)$, where Ω are the fixed parameters of the true parameters of the distribution, the conditional choice probability becomes

$$S_{jq}(\gamma_q) = \exp\left(\alpha_{jq} + \beta' x_{jq} + \gamma_{jq}\right) / \sum_k \exp\left(\alpha_{kq} + \beta' x_{kq} + \gamma_{kq}\right), \tag{3}$$

for a given value of γ_q. However since γ_q is unknown, it is not possible to condition on γ_q. Therefore, we use the unconditional choice probability which is the logit formula integrated over all values of γ_q weighted by the density,

$$P_j = \int S_{jq}(\gamma_q) f(\gamma_q|\Omega) d\gamma_q. \tag{4}$$

This integral is evaluated with a simulated maximum likelihood estimator using Halton draws[17]. In our case, it is not obvious which distribution to assume for each parameter since there is no clear-cut prior information. Therefore, we assume a normal distribution for all the attributes (except the cost) in our experiment. It is also worth noting that our data consists of several observations from the same individual. This potentially gives rise to correlated

[17] Halton draws are more efficient than standard random draws. The number of draws has been discussed in the literature; see e.g. Bhat (2001) and Train (2000). With the Halton procedure, it has been found that 25 draws may produce stability, but larger numbers are preferred (typically a minimum of 100 draws).

responses across observations via the sequencing of choice sets and possible learning and inertia effects. This potential problem is, to some extent, dealt with since our choice sets are randomly ordered for each respondent.

In the final specification the vector X of explanatory variables contains the attribute levels defined by table 1. The first four attributes in table 1 have been 'dummy-coded' so that the base level of each attribute is 'no-effect', 'no', 'same amount' and 'outside Europe', respectively. The cost attribute has been divided by 1000 but not dummy-coded. The advantage of dummy coding is that it allows for non-linearity in the attribute levels. With standard dummy coding however, the base level of an attribute will be perfectly confounded with the overall mean (constant) – the base-level utility cannot be separated from the overall mean. Therefore, we used the alternative approach of effects-coded attributes. The basic intuition follows standard dummy codes although the base-level is now set to -1 instead of 0. Given our specification, nine parameters need to be estimated – the total number of attribute levels, minus one for each attribute, plus the parameter corresponding to the cost and a constant. The parameter estimates measure the effect that a particular attribute level has on the choice (dependent variable) which, therefore, also reflects the marginal utility of the particular attribute level. Finally, by defining the marginal rate of substitution for each attribute level in terms of the cost parameter, a monetary value can be attached to the utility change from each attribute level.

4. Estimation results

The random parameter logit, and the standard logit, have been estimated in NLOGIT 4. For the labeled experiment, it is straightforward to include an alternative specific intercept (constant) to explicitly capture the label-effect. For the unlabeled experiment is not obvious why to include an alternative specific intercept – there is no obvious rationale for choosing one alternative before the other. Still, it is possible that respondents derive some intrinsic utility from always choosing one, or the other, alternative. Therefore, we decided to include an alternative specific constant for the unlabeled experiment as well. This has become more or less common practice in the literature and produces a better model-fit in our case. In our model specification, all parameter estimates, except for the cost attribute, are assumed to be randomly distributed with a normal distribution. To us, there is no obvious reason to assume any other distribution since it would impose a substantial restriction on the estimates. For example, a log-normal distribution would have restricted the parameter estimate to be strictly positive. As for the fixed parameter of the cost attribute, it is convenient to assume non-randomness when calculating the marginal willingness to pay for an attribute. Moreover, the non-randomness assumption also restricts the cost variable to be negative for all individuals. This, to some extent, follows the existing literature and implies that the 'willingness to pay' (WTP) has the same distribution as the parameter estimate; see e.g. Carlsson et al. (2003).[18]

For both the unlabeled and labeled experiment, the estimated standard deviations in the RPL model are significant which indicates heterogeneity in preferences among the respondents. The likelihood ratio for both split-samples tells us that the RPL model improves the model-fit by comparison to the standard logit model. As can be seen in tables 3 and 4, all parameter estimates are significant at the 5% level. The respective sign of each coefficient are potentially very interesting. To begin with, a change in the technology effect from 'no' to 'positive' increases the probability of choosing that alternative, while a change from 'no' to 'negative' tends to decrease the probability. Moreover, policies that increase the climate awareness tends to increase the probability of choosing that alternative. Continuing with distribution of cost, the base level is 'same amount' which should be interpreted as a regressive tax system. Accordingly, a change from a regressive tax system to a more progressive system (the 'same share' level included) works to increase the probability of choosing the policy. As for the geographic burden of the emissions reduction, we find that it is positive if the reduction takes place in the European region but not in Sweden (outside Europe is the base level). Finally, the cost for the reduction in CO_2 has a negative impact on the probability of choosing a policy.

A potentially very interesting result arises from the alternative specific constant (ASC). For the unlabeled experiment, it is obvious that there is a tendency for picking the first alternative (the coefficient is positive). We do not have any good explanations for this result but recalls that there should be no difference between alternative A and B since they are generic by construction. In light of the labeled experiment this finding becomes even more interesting since the alternative specific constant, reflecting the label-effect, becomes significantly negative. Accordingly, although the tax alternative is the first alternative, the alternative

[18] Denote the fixed cost parameter as β_1 and an attribute with a normally distributed parameter with mean β_2 and standard deviation β_3. The willingness to pay for the attribute then becomes normally distributed with mean β_2/β_1 and standard deviation β_3/β_1. In our marginal WTP measures, we have taken the point estimates as given and ignore the sampling variance in these estimates.

specific constant turns negative, which makes the negative label-effect from ‘tax’ even stronger.

Generally, the interpretation of the coefficient values is not straightforward in terms of absolute numbers. The calculated WTP for a change in each of the attribute levels therefore work to increase the understanding. As can be seen from the tables, the WTP measures are significantly different from zero. Moreover, since the absolute WTP-values are non-trivial, this illustrates the importance of each attribute in a real-world choice situation. The interpretation of the differences in WTP between the two split-samples is not obvious. The results show that ‘income distribution’ is valued more in the unlabeled experiment than in the labeled. To speculate, one interpretation could be that the tax label is perceived to reflect some implicit income distribution. Does the tax label signals a progressive distribution since this is typical for the income tax-system in Sweden?

Table 3. The unlabeled experiment, standard error within parenthesis.

	Logit	Random parameter logit	Random parameter logit	Willingness To Pay
	Coefficient	Coefficient	Standard error	Coefficient (SEK)
ASC	0.213*** (0.020)	0.292*** (0.036)		
Technology (positive)	0.315*** (0.021)	0.427*** (0.041)	0.0307 (0.208)	139.119*** (11.5)
Technology (negative)	-0.266*** (0.022)	-0.412*** (0.042)	0.313 (0.366)	-134.415*** (12.7)
Climate awareness (yes)	0.240*** (0.016)	0.389*** (0.038)	0.827*** (0.133)	126.789*** (8.8)
Income distribution (progressive)	0.204*** (0.018)	0.319*** (0.037)	0.129 (0.276)	104.075*** (9.6)
Income distribution (neutral)	0.141*** (0.018)	0.234*** (0.029)	0.371* (0.198)	76.356*** (8.3)
Reduction within Sweden	-0.117*** (0.019)	-0.143*** (0.030)	0.800*** (0.141)	-46.622*** (9.8)
Reduction within EU (not Sweden)	0.179*** (0.019)	0.296*** (0.033)	0.769*** (0.162)	96.548*** (9.9)
Cost	-2.007*** (0.042)	-3.068*** (0.190)	Fixed	
Log-likelihood	-7,879	-7,847		
McFadden Pseudo R-squared		0.214		
No. of respondents	1,200	1,200		
No. of observations	14,400	14,400		
No. of Halton draws		160		

Table 4. The labeled experiment, standard error within parenthesis.

	Logit	Random parameter logit	Random parameter logit	Willingness To Pay
	Coefficient	Coefficient	Standard error	Coefficient (SEK)
ASC	- 0.063*** (0.018)	-0.131*** (0.038)		
Technology (positive)	0.223*** (0.018)	0.352*** (0.041)	0.057 (0.227)	165.613*** (15.9)
Technology (negative)	-0.186*** (0.020)	-0.324*** (0.042)	0.749*** (0.193)	-152.809*** (17.4)
Climate awareness (yes)	0.167*** (0.014)	0.308*** (0.36)	0.911*** (0.160)	144.834*** (12.4)
Income distribution (progressive)	0.084*** (0.017)	0.152*** (0.033)	0.050 (0.237)	71.567*** (14.0)
Income distribution (neutral)	0.076*** (0.017)	0.142*** (0.028)	0.033 (0.259)	66.638*** (11.8)
Reduction within Sweden	-0.064*** (0.017)	-0.062*** (0.030)	0.968*** (0.186)	-29.362*** (14.4)
Reduction within EU (not Sweden)	0.084*** (0.017)	0.159*** (0.031)	0.676*** (0.225)	74.883*** (14.0)
Cost	-1.261*** (0.036)	-2.132*** (0.149)	Fixed	
Log-likelihood	-8,921	-8,890		
McFadden Pseudo R-squared		0.105		
No. of respondents	1,194	1,194		
No. of observations	14,328	14,328		
No. of Halton draws		125		

4.1. Policy simulations

The results from the choice experiment can now be used to 'simulate', or illustrate, different policy packages characterized by different combinations of attribute levels. Such simulations may be of interest as illustrations of the utility change, and hence willingness to pay, for different policy packages.

First, we define a reference policy package with attributes that approximately corresponds to the current Swedish climate-policy. The utility level attached to this reference package is denoted U_0, whereas the utility attached a hypothetical alternative policy is denoted U_1. The utility from changing policy can then be written as

$$\Delta U = U_1 - U_0 = \alpha + \beta X^1 - (\alpha + \beta X^0) = \beta \Delta X \ , \qquad (5)$$

where α and β are the estimated parameters (β is a vector), and X is the vector of variables corresponding to the β vector. Then, by dividing with the marginal utility of money (the cost parameter), we obtain the willingness to pay for a change between the two alternative policy scenarios, i.e.

$$\Delta WTP = -\frac{1}{\beta_{\cos t}} \cdot \beta \Delta X \ , \qquad (6)$$

where the vector β does now not include β_{cost}.

The current Swedish climate policy has two very central components – the CO_2 tax and the European Union Emission Trading Scheme (EU-ETS). As for the CO_2 tax, it is an explicit tax on the CO_2 content of fossil fuel and differentiated in the sense that the industry sector faces a lower rate than the non-industry sector. On the other hand, a large portion of the industry is included in the EU-ETS.[19] Accordingly, it is fair to say that current Swedish policy measures can be characterized as 'market based', aiming at reductions within Sweden and to some extent within other European countries. Given the attributes characterizing policy measures in our study, we have tried to construct a reference scenario with the objective to match Swedish policy (denoted SC-0 in what follows).

The reference scenario (SC-0) will be compared with two other scenarios that are supposed to reflect somewhat different, but still relevant, policy packages. The first alternative scenario (SC-1) reflects a "global trading" (or global tax) scenario. That is, emission reductions are allowed to be outside Sweden and Europe, and the scenario is assumed to imply incentives for development of new technologies, but not to create any specific climate awareness among Swedes. Moreover, this scenario is supposed to be neutral in cost distribution. The second scenario (SC-2) is more of a "campaign" scenario. Reductions are taken place within Sweden, relatively low incentives for technology development, but a high degree of climate awareness among Swedes. The distribution of costs will be relatively progressive (potentially financed through an income tax).[20]

Given the scenarios above, we calculate the willingness to pay for a change from SC-0 to each of the two alternative scenarios, respectively. Table 5 summarizes the scenarios with the corresponding attribute levels and the WTP for a change from SC-0.

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[19] The lower rate for the industry is not applicable for vehicle fuels (diesel and gasoline). For a recent review of Swedish climate policy in general and the CO_2 tax and energy taxes in particular, see Brännlund (2009).

[20] Of course, there are a number of other possible policy packages. Recall, however, that the effect from packages with a change in just one attribute is found from the corresponding estimate presented in the results section.

Table 5. Scenarios and the attribute levels, standard error within parenthesis.

Attribute	SC-0	SC-1	SC-2
Effect on the development of environmentally-friendly technology.	Positive effect	Positive effect	Negative
Increased climate 'awareness' among Swedes.	Yes	No	Yes
Social distribution of costs.	Regressive	Neutral	Progressive
Geographic distribution of the reduction in emissions.	Sweden	Not Sweden	Sweden
ΔWTP[21], SEK (unlabeled)	-	-0.096 (33.082)	10.973 (22.806)
ΔWTP, SEK (labeled)	-	-100.785 (46.714)	-108.550 (33.413)

In general, each parameter estimate has a variance and it is difficult to find statistically significant estimates of the WTP for a change from one scenario to another. Basically, the variance is increasing with the number of needed parameter estimates in the utility-change. Nevertheless, given the results presented earlier in the paper, it is perhaps expected that a change to "global trading" policies (SC-1) does not matter to Swedes (with estimates from the unlabeled experiment). By looking at the point estimates, people value the social distribution of cost and the geographic distribution approximately equal as the loss of climate awareness effects. People dislike regressive cost distributions and domestic reductions of CO_2, but like increased climate awareness.

As for the hypothetical change to a 'CO_2 campaign', it tends to have a positive WTP although not significant at any reasonable level (with estimates from the unlabeled experiment). In this case, the point estimates give us that people tend to value the positive effect on the social distribution of cost (regressive to progressive) more than the negative effect on climate friendly technology. Recall that, for a choice of policy without any 'trade-offs' (see table 2), respondents preferred a campaign alternative. This is hence not supported (significant) when respondents are faced with the 'trade-offs' implicitly captured by the different attributes including the 'cost'.

[21] The WTP for a change is calculated from equation (6) and the standard errors are calculated with the Wald command in Limdep. It is important to recall that the variables (attributes) are dummy-coded with a 'base level' of -1.

To conclude, the policy 'simulation' does not give decision makers any clear-cut guidance of how to change their policies – CO_2 policies have many built-in characteristics and trade-offs. In addition, it turns out to be important that the WTP measures found in the simulation is calculated from the estimates in the unlabeled experiment. By using the estimates from the labeled experiment, a change from SC-0 to any of the other scenarios implies a negative WTP of approximately 100 SEK (significant at the 5%-level of significance). However, since we believe that estimates from the unlabeled experiment are the most relevant in the simulation setup, this only reflects how sensitive the WTP measure becomes for a simulated policy change.[22]

5. Summary and discussion

The purpose of this study has been to provide better understanding of the public's attitudes toward climate policy measures and their inherent characteristics. The reason for this particular interest is the obvious deviation between the climate policy recipe found in textbooks in environmental economics, and actual policy. The textbook recipe is crisp and clear, stating that a uniform tax, or a single market for emissions trading, will be sufficient as a policy measure. Actual policy, on the other hand, is far from clear in the sense that numerous different policy measures are implemented side by side, in which taxes and permit markets in some cases are included. There are many potential reasons for this deviation, although it is fair to say that the textbook recipe only consider efficiency, whereas in reality there are other social goals that have to be considered. Policy-makers may consider e.g. equity, regional distribution and ideological preferences. This study then, where we present the results from an Internet-based choice experiment, shed some light over the question why people tend to prefer one policy measure over the other. However, it may also serve as guidance to policy makers, taking not only efficiency arguments into account.

The results show that all the attributes included in the experiment have a significant impact on individual's choice of preferred policy. Furthermore, the results clearly shows that a policy that has the label "tax" is disliked, relative to a policy which do not have the "tax" label. That is, given the same attribute levels, the probability for picking the one with the tax label is less than if it not labeled as a "tax".

[22] It is not relevant to use estimates from an experiment with the labels 'tax' and 'other' if we are to simulate respondents preferences for other types of policies.

Concerning the attribute levels, it is shown that people prefer instruments with a positive effect on environmentally-friendly technology and climate awareness. A progressive-like cost distribution is preferred to a regressive cost distribution, and the private cost is negatively related to the choice. Finally, the results indicate that Swedes want the reduction to take place in Europe but not necessarily in Sweden.

The purpose with the "policy simulations" is to illustrate how a change in policy may affect utility in terms of WTP. Here, we consider two hypothetical scenarios relative to a (hypothetical) reference scenario. The results from the scenario analysis do not give policy makers any clear-cut guidance on what type of policy to pick if they were to consider peoples preferences and maximize utility. In addition, the different scenarios are constructed for illustrative purposes and give, of course, a very simplistic picture of any real-world situation.

There are of course weaknesses with a choice experiment study as ours. To begin with, a survey is always faced with potential cognitive and perception problems/biases. As a researcher, you can never guarantee that respondents understand and interpret your given questions and information as expected. Moreover, the survey is web-based and we have relatively little experience whether such studies are biased in one way or another. In our case, we think that our sample is representative for the Swedish population, but we do not know anything about drop-out preferences etc.

As for future research, it is of course important to further explore people's preferences for policy measures. In addition, an increase in the use of web-based surveys will hopefully give us valuable inputs on how to interpret and handle unobserved drop-outs etc.

Appendix

Below you find examples of the choice-questions in the unlabeled- and labeled experiment, respectively.

Question… (an example from the unlabeled experiment)

Consider the following policies, A and B. Which of these two, A or B, do you choose for a reduction in CO_2 by 2,4 million tons (4 percent). Tick one of the alternatives.

	POLICY A	**POLICY B**
Effect on the development of environmentally-friendly technology.	NEGATIVE	NO EFFECT
Increased climate 'awareness' among Swedes.	NO	YES
Social distribution of costs.	Higher income citizens pay a larger share (higher percentage) of income	All citizens pay the same amount
Geographic distribution of the reduction in emissions.	Sweden: 0 ton Europe (not Sweden): 2,4 million ton Outside europe: 0 ton	Sweden: 2.4 million ton Europe (not Sweden): 0 ton Outside europe: 0 ton
Monthly cost (private) until 2012.	1000 SEK	300 SEK
My choice (tick your choice)	[ ]	[ ]

Note! Both policies reduce the total emission of CO_2 by 2,4 million ton each, no more no less.

Question… (an example from the labeled experiment)

Consider the following policies, A and B. Which of these two, A or B, do you choose for a reduction in CO_2 by 2,4 million tons (4 percent). Tick one of the alternatives.

	TAX	**OTHER**
Effect on the development of environmentally-friendly technology.	NEGATIVE	NO EFFECT
Increased climate 'awareness' among Swedes.	NO	YES
Social distribution of costs.	Higher income citizens pay a larger share (higher percentage) of income	All citizens pay the same amount
Geographic distribution of the reduction in emissions.	Sweden: 0 ton Europe (not Sweden): 2,4 million ton Outside europe: 0 ton	Sweden: 2.4 million ton Europe (not Sweden): 0 ton Outside europe: 0 ton
Monthly cost (private) until 2012.	1000 SEK	300 SEK
My choice (tick your choice)	[ ]	[ ]

Note! Both policies reduce the total emission of CO_2 by 2,4 million ton each, no more no less.

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