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Analysis

A choice experiment on fuel taxation and earmarking in Norway

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ABSTRACT

Pigouvian taxes are efficient — but unpopular among voters — and hence often politically infeasible. Earmarking of revenues has been widely reported to increase public support for taxes, but earmarking is generally not the most efficient use of the revenues. This trade-off between efficiency and political feasibility is the motivation for our primary research objective: to quantify the effect of earmarking on support for fuel tax rises. Our secondary research objective is to investigate *why* earmarking increases support. Using data from a representative sample of the Norwegian voter population (N = 1147), we estimate models of voter preferences for fuel taxes using logistic regression models. Our results show that, in the absence of earmarking, the majority of voters would like to reduce fuel taxes, but earmarking the revenues for environmental measures has a substantial effect on voter support for fuel tax increases, garnering a majority for increases of up to 15% above present levels. Further analysis indicates that a prime reason why earmarking for environmental measures is popular is that it increases the perceived environmental effectiveness of the tax, and hence its legitimacy as an environmental rather than a fiscal policy instrument.

1. Introduction

According to economic theory, imposing Pigouvian taxes can improve efficiency when there is an environmental externality. In political practice, however, implementing Pigouvian taxes has proven challenging. The consequence is that some externalities are left unaddressed, while others are addressed through sub-optimal instruments. When taxes are imposed the rate is often set below the optimal level. In addition to uncertainty about the marginal abatement costs and marginal damage costs, a prime reason for these deviations from optimal policy design is public opposition.

Whereas economists recommend that government spending decisions should be divorced from its taxation decisions, earmarking has been widely reported to increase the public acceptability of taxes (Banister, 2003; Harrington et al., 2001; Hsu et al., 2008; Ison, 2000; Schade and Schlag, 2003; Schuitema and Steg, 2008; Steg et al., 2006; Thalmann, 2004). Because it represents an important trade-off between acceptability and efficiency, the primary research question for this study is *to what extent* earmarking can increase the public acceptability of environmental taxes. The secondary research question is *why* earmarking increases public acceptability.

The next section presents a review of the literature on earmarking, with a particular focus on the role of earmarking in garnering public support. Based on this literature review we define our research hypotheses in Section 2. We present the survey and method in Section 3, analyze the responses in Section 4, and draw our conclusions in Section 5.

1.1. Literature Review

The issue of earmarking and support for environmental taxes has been discussed in both the public finance/political economy literature, and in the environmental economics literature. We will briefly review the discussion on whether or not revenues ought to be earmarked, before we turn our attention to the main topic of this paper: why and to what extent can earmarking increase the public acceptability of environmental taxes?

In public finance theory, the textbook recommendation is that the government should divorce its spending decisions from its fund-raising or taxation decisions, so that spending can be undertaken unconstrained and solely based on benefit–cost considerations (Musgrave and Musgrave, 1984, p.231). There are also other arguments against earmarking of general taxes. Dilnot and Studies (1993) and Wilkinson (1994) both argue that citizens can be deluded when the government makes offsetting decisions on other issues in which there is no earmarking. One well known example is that in US "states where lottery revenues are earmarked for education, lottery revenues actually substitute for general fund expenditures" (Stanley and French, 2003).

It should be noted that under certain conditions a theoretical argument can be made for the efficiency of earmarking. Buchanan (1963) and Goetz (1968) argue that when there is a high degree of correspondence between who pays the tax and who benefits from the use of revenues, earmarking reveals taxpayer preferences for public

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services, sending a clear demand signal to policy makers about how much of the public services should be supplied. This has been noted even by Musgrave (1939), who can be seen as the father of the orthodox public finance approach, although he has been careful to specify the limited practical applicability of the argument. Indeed, the applicability is limited to user charges for services whose characteristics are closer to private than public goods. The types of earmarking that will be considered in this study do not satisfy criteria for efficient earmarking outlined by Buchanan (1963) and Goetz (1968). In summary, it is clear that the economic rationale for earmarking applies only in some limited cases. It may, however, make good political sense. An important argument is that earmarking taxes makes them more popular and increases the likelihood that they will be implemented.

The general efficiency argument in favor of divorcing taxation and spending decisions has also been important in environmental economics. The question of whether a Pigouvian tax will impose net costs or net benefits — when environmental benefits are excluded — has been hotly debated. There are two forms of the so-called double dividend hypothesis. The weak form of the hypothesis is relatively undisputed: the second dividend of the environmental tax comes in the form of improved efficiency if its revenues can be used to cut distortionary taxes (the first dividend is environmental improvements). The strong form of the hypothesis is that the tax actually increases non-environmental welfare independent of whether there are any environmental benefits. Whether the strong form holds is unclear and depends on the tax structure of the economy (Schöb, 2005). The weak form of the double-dividend hypothesis is widely accepted. Earmarking revenues from an environmental tax for other public projects (as opposed to using them to lower distortionary taxes) has the effect that the second dividend will not materialize.

The result that earmarking the revenues from an environmental tax would increase public acceptability seems very robust and is confirmed by a wide range of studies across many countries.

An international poll of 22,000 people in 21 countries found that 50% supported higher energy taxes, and that the support rose to 77% if the revenues were earmarked for promoting energy efficiency or developing cleaner fuels (Globescan and PIPA, 2007). Similar results are found by, for instance Banister (2003), Harrington et al. (2001), Hsu et al. (2008), Ison (2000), Schade and Schlag (2003), Schuitema and Steg (2008), Steg et al. (2006) and Thalmann (2004). One weakness shared by many of the existing studies is that the respondents face only two options: an earmarked tax and a non-earmarked one. Hence, analyst may only obtain an estimate of how much a specific earmarking proposal can increase acceptability, but are unable to draw more general conclusions.

Given its popularity, it is perhaps not surprising that earmarking of revenues from taxes on externalities is relatively common. The OECD and the European Environment Agency in cooperation provide a database of environmental policy instruments.[1] As of July 2010 200 of the 626 national or state level environmental taxes listed in the data base were wholly or partially earmarked (OECD, 2010).

There are numerous studies that confirm the popularity of earmarking. There is, however, no consensus on *why* earmarking increases acceptability. In fact, there are several competing explanations. These can broadly be classified as relating to self-interest, distrust of government, and a desire for an issue-linkage.

1.1.1. Self-interest

To an economist it is natural to look for the element of self-interest. Schuitema and Steg (2008) find support for the idea that "acceptability of transport pricing increases when car users expect to benefit from the allocation of revenues, which is especially the case when revenues are allocated to decrease fixed car-taxes (viz., road taxes) and variable car-taxes (viz., fuel taxes)." While imposing an environmental tax that internalizes external costs will increase overall welfare, it will not necessarily increase the welfare of all. Eliasson and Mattsson (2006) study the equity effects of the (then proposed, now implemented) Stockholm congestion charge. They find that the use of the revenues is crucial for the net distributional effects: an effect that is accentuated by "the fact that the total collected charges are more than three times as large as the net benefits". A rational self-interested voter would support an environmental tax scheme only if he or she expected to gain a personal benefit if the tax were implemented — and this depends crucially on the use of the revenues.

1.1.2. Distrust

Rivlin (1989) made the suggestion that earmarking is popular because without earmarking taxpayers have no clear idea of what the money is spent on, and they might believe it is spent "wastefully or even fraudulently, or that a substantial part of it goes for a services of which they disapprove of". Goode (1984, p. 12) argues that the "prevalence of earmarking indicates a lack of confidence in the governmental system and the budgetary process". Dresner et al. (2006a) identified "lack of trust that the government would do what it promised with the revenues" as a fundamental problem facing ecological tax reform.

If people support earmarking only because they are worried that the revenues might otherwise be spent "wastefully or even fraudulently", any specific use of the revenues should work equally well in terms of garnering public support.

1.1.3. Issue-linkage

A further reason why people might support earmarking is that many do not believe that taxation will do much to change behavior on its own, hence, if the tax is to improve the state of the environment, the revenues must be earmarked for environmental purposes — according to this belief. Dresner et al. (2006a, 2006b) found that "what seemed to underlie the thinking among both focus groups and some businesses was a view of taxes solely as a means of raising revenue, rather than in terms of their incentive effects. Many people could not understand that a tax on energy would have benefits for the environment even if the revenues went to labor tax reductions." This idea is also supported by other studies. Kallbekken et al. (2011) ran a laboratory experiment with a market externality where participants voted on Pigouvian tax schemes. Only 23% of participants answered correctly in the post experimental survey that imposing the tax would improve overall welfare (in the form of monetary payoffs). Even in a treatment where it was explained to the participants how Pigouvian taxes could improve overall welfare, only 51% answered the post experimental survey question correctly. Finally, Steg et al. (2006) found that "push measures" such as taxes "were perceived to be more effective and acceptable when revenues are allocated within the energy domain rather than to general funds." While the finding that people perceive taxes as more *acceptable* when the revenues are earmarked should surprise no one, it is interesting that the respondents also perceived them to be more *effective* if earmarked.

The participants in a focus group study by Kallbekken and Aasen (2010) strongly supported earmarking, and more specifically preferred the revenues to be earmarked for mitigating environmental damage, subsidizing environmentally friendly alternatives, or financing R&D of such alternatives. Dresner et al. (2006a, 2006b) also find a strong preference among the respondents for measures that would bring visible environmental benefits, preferably local benefits. These findings are complemented by the result that respondents often reject suggestions to spend the revenues on other measures: Deroubaix and Leveque (2006) find that people view is as "nonsensical to link the implementation of an energy tax and the reduction of labor taxes".

[1] The quality of the data is highly variable. Several of the taxes in the database might have been more appropriately classified as user fees rather than environmental taxes (in the Pigouvian sense).

2. Research Questions and Hypotheses

The two overall research questions for this study are why and to what extent earmarking can increase the public acceptability of environmental taxes. More precisely the two research questions are:

1. By how much can earmarking the additional revenues from an increase in the fuel tax rate raise the level of popular support compared to a non-earmarked tax rate increase?
2. Why does earmarking increase the public acceptability of a tax increase?

In order to address these research questions we define five testable hypotheses. Relating to research question 1 we test the hypotheses:

H1A. On average, people prefer lower fuel taxes.

H1B. Earmarking of revenues increases public support for a fuel tax for a given tax rate.

While the first hypothesis may seem obviously true, Jaensirisak et al. (2005) noted in a study on the acceptability of road pricing that "surprisingly little attention has been paid to the impact of the level of the charge on acceptability"

Relating to research question 2 we test three hypotheses, each one relating to one of the theories presented in the literature review ("self-interest", "issue-linkage" and "distrust").

H2A. Earmarking is popular because voters expect to benefit personally from the use of the earmarked revenues.

H2B. Earmarking increases the acceptability of environmental taxes because of distrust in government spending of revenues. The reasoning is that with earmarking the public can be certain of what the revenues will be spent on, and the direct link between taxation and spending makes it easier to track the money and hence to trust the process.

H2C. Earmarking is popular because people are concerned about the environmental effectiveness of the tax. Without earmarking they do not believe that the tax will improve environmental quality. The reasoning is that people do not understand how the tax gives incentives to change behavior. Thus, they want taxation and spending to be linked to the same domain/activity to ensure that the tax addresses the problem it is indeed meant to address.

3. Material and Methods

To investigate public preferences for fuel taxation, a representative sample of the Norwegian population was given a series of pair-wise choices between different hypothetical proposals for changes to the fuel tax. [2] This method is known in the literature as a choice experiment (CE). The series of choices were delivered to respondents through an online survey, which also included sociodemographic and attitudinal questions. The data collected in this way were used to estimate a model of public preferences for fuel taxation, where the main explanatory variables were the change in the tax level and the use of the additional revenue (if any). By estimating an explicit model, we can test our hypotheses in a formal way, and in a more general sense than would be possible based on the point observations that form the basis of existing knowledge on the topic. The method has the advantage of presenting respondents with choice tasks that are relatively easy to comprehend, and then using advanced statistical analysis to uncover a detailed model of preferences, which includes heterogeneity between people. The estimators of preferences are consistent with economic theory.

Table 1
Example of choice task.

	A	B	Cannot answer/do not know
Fuel tax increase per liter	NOK 1	NOK 2	–
Use of additional revenues	Income redistribution	Environmental policies	–
Tick for the preferred alternative			

3.1. Choice Experiments

Economic methods for the empirical investigation of preferences can be divided into two main groups. Revealed preference methods analyze actual transactions in markets, while stated preference methods rely on surveys with hypothetical choice situation. The choice experiment (CE) approach — an example of the latter — was initially developed by Louviere and Hensher (1983) and Louviere and Woodworth (1983). It presents respondents with a series of choice tasks with two or more alternatives and asks them to choose their most preferred alternative. An example of a choice task facing respondents in our survey is presented in Table 1. The approach has been applied extensively within inter alia transport studies (pioneered by McFadden, 1974), marketing (see e.g. Carson et al., 1994), and valuation of non-market goods (e.g. Birol et al., 2006; Campbell et al., 2008; Carlsson et al., 2003; Carlsson and Martinsson, 2001; Hanley et al., 1998). To the best of our knowledge this is, however, the first time a choice experiment has been used to address the issue of public acceptability of policy instruments.

3.2. Choice Experiment Design

Because our hypotheses concern the level of tax increase, and the use of the additional revenues, the alternatives facing respondents in this survey are described in terms of these two attributes: 1) the increase in the tax level, and 2) the use of the additional revenues generated relative to the status quo. The level of the increase takes one of five possible values: 0, NOK 0.5, NOK 1, NOK 2, and NOK 4. The use of additional revenues takes one of three different values: 1) *unspecified*, i.e. the revenues are used for general fund financing or for lowering other taxes. 2) earmarking for *income redistribution*, i.e. lowering the income tax in a way that benefits primarily low-income households. 3) earmarking for *environmental measures*, i.e. supporting public transport, construction of bicycle and footpaths, noise screening, or development of clean technologies. When the tax increase is zero, the second attribute is not applicable, as there is no additional revenue to spend. A translation of text introducing the choice scenarios is found in Appendix A. [3]

The choice of these three potential uses of the additional revenues will help us address our hypotheses regarding why earmarking increases acceptability: Hypothesis 2B states that people like earmarking because they distrust government and fear that non-earmarked revenue will be spent on something wasteful or fraudulent, as Goode (1984), Rivlin (1989), and Dresner et al. (2006a) argue. If this is correct one would expect the popularity of the two earmarked options to differ only to the extent that environmental measures are viewed as a more or less worthy cause than providing support to low-income households. If, in contrast, earmarking is popular due to a concern about the environmental effectiveness of the

[2] Tax rates in Norway are not decided by referendums. The framing of the question is hence one the respondents are not used to, but, we believe that its simplicity of understanding makes it the best option for investigating preferences for fuel taxes and earmarking.

[3] An English translation of the questionnaire as a whole is available from the authors upon request.

tax (hypothesis 2C), one would expect that earmarking for environmental measures is significantly more popular than earmarking for support to low-income households.

We used the software Sawtooth to combine the respective values of the two attributes into alternatives. Next, the alternatives were paired up to form choice sets, which were then combined into series of eight to form a choice experiment. We used a random design strategy, which means that the design of the choice experiment varied between respondents. Compared with traditional design strategies where all respondents face the same experiment, this greatly increases the number of combinations occurring, which means that the estimation of the econometric model becomes more robust. In addition, potential bias from learning, fatigue and ordering effects is reduced. In total 300 unique choice experiments were generated. The specific design strategy we used is called complete enumeration. This strategy combines nearly orthogonal design (near zero correlation between attributes) for each respondent with minimal overlap (alternatives within each task are kept as different as possible). For details see Sawtooth Software (2010). In the final design for the sample as a whole, each combination of the possible values of the two attributes occurs in the same number of choice sets. In addition to the choice experiment, the questionnaire also contained a number of sociodemographic and attitudinal questions.

3.3. Sampling and Delivery of Survey

In March 2010 we conducted a nationwide online survey of the part of the Norwegian population who are internet users. The most recent statistics (Statistics Norway, 2010) show that 90% of Norwegian households have access to internet in their homes. The distribution of the questionnaire was handled by the professional survey company Synovate. It was delivered to a sample of 2777 people representative of the adult Norwegian population in terms of gender and region. People under the age of 18 (the voting age) were excluded, but other age groups were proportionally represented. The recipients had previously been recruited to a web panel and agreed to receive periodic surveys. As an incentive to participate, respondents were offered the chance of winning one out of five "universal" gift cards worth NOK 1000 each.

3.4. Econometric Method

The analysis of choice experiments has two foundations in economic theory. The first is Lancaster's characteristics theory of value (Lancaster, 1966), which postulates that any good can be completely described in terms of a bundle of characteristics and the values that these take. In our case, a tax increase is described in terms of its monetary level and the use of the revenues. The other foundation recognizes that in addition to these observable characteristics, there may be some relevant aspect of a good that is unobservable, or observable only with an error. According to the Random Utility Model (RUM) (Luce, 1959; McFadden, 1973) the preference of any respondent $\underline{i}$ can be represented by an indirect utility function U_i that is decomposed into a deterministic element (V), which is typically specified as a linear index of the attribute vector (X) of the $\underline{j}$ different alternatives in the choice task, and a stochastic element (e), which represents unobservable influences on the respondents choice:

$$U_{ij} = V_{ij}\left(X_{ij}\right) + e_{ij} = \beta_i X_{ij} + e_{ij} \quad (1)$$

When choosing between different goods, the respondent is assumed to select the alternative that gives him or her the highest utility. Because of the stochastic component e, choices cannot be predicted with certainty, and the analysis becomes probabilistic. To estimate the function V from our empirical data, we employ the mixed logit model popularized by Train (1998). We interpret the model in terms of random parameters, which is one out of several ways to derive the model that are formally equivalent but provide different interpretations (Train, 2003). The reason for choosing the mixed logit model is that, unlike the more basic conditional — or fixed parameters — logit model, the vector of coefficients β is allowed to vary across individuals, hence incorporating preference heterogeneity. This specification also embraces the panel nature of the data, unlike the fixed parameters logit, which treats multiple observations of the same individual as independent. With the mixed logit model it is necessary to specify a functional form for the distribution of each random coefficient in the population. Since there is little information about how these preferences are actually distributed, we use the most standard assumption, which is the normal distribution: $f(\beta) \sim N(\mu, \sigma^2)$ where μ and σ are parameters to be estimated.[4] The model is estimated with simulated maximum likelihood estimation using a Stata module developed by Hole (2007a).[5]

In our model of V, we include four variables. The level of the tax increase proposed is included in the continuous variable tax rise. Use of revenue is a categorical variable, and must therefore be dummy-coded. The dummy labeled environment indicates that the additional revenue is earmarked for environmental measures, while the dummy redistribution indicates that it is earmarked for income redistribution. We chose unspecified use of revenue as the reference category; hence there is no dummy variable for this option. When tax rise takes the value of zero, there is no additional revenue to spend. The dummy variable zero tax rise identifies these cases. For each of these variables, we will estimate a stochastic coefficient, described in terms of the mean and standard deviation.

We can now specify statistical tests corresponding to our first two hypotheses. Our Hypothesis H1A that people on average prefer lower taxes is operationalized as:

$H1A_1$: $\mu(\text{tax rise}) \leq 0$
$H1A_0$: $\mu(\text{tax rise}) = 0$

The hypothesis that earmarking increases support is specified as

H1B1. $\mu(\text{redistribution}) \geq 0 \cap \mu(\text{environment}) \geq 0$

H1B0. $\mu(\text{redistribution}) = \mu(\text{environment}) = 0$

In order to investigate why earmarking is popular, we will analyze how certain personal attributes affect preferences for earmarking. Personal characteristics cannot be entered directly into the mixed logit model, since they do not vary across choice alternatives. However, they can be interacted with attributes of the alternatives. Hence one can find out what types of people prefer the different uses of revenues. The personal attributes included are selected in order to differentiate between the three hypotheses (H2A, H2B and H2C) regarding why earmarking increases acceptability. They are elicited by presenting respondents with a series of statements and asking them to indicate the extent to which they agree on a five-point Likert

[4] A limitation of the mixed logit model is that it assumes that the variance of the error term is constant across individuals. Recently, generalizations of the mixed logit model have been developed that relax this assumption. (Feinberg, 2010; Salisbury and Feinberg, 2010) These models have been shown to outperform the mixed logit model, but present challenges of software availability and simulations by Greene and Hensher (2010) suggest that the difference may not be of such great empirical consequence especially when WTP measures are of interest.

[5] The normal distribution imposes an assumption of symmetry on the distributions of the coefficients. Since this is a non-trivial assumption, we will check the results relative to a model with triangular distributions that do not impose symmetry, using a program developed by Train (2006). The need to impose a distribution upon the random parameters is a drawback of this model. However, simulations by Torres et al. (2011) show that — if real preferences are heterogeneous — assuming the wrong distribution is less critical than assuming that preferences are homogeneous (which the conditional logit model does), in terms of the bias introduced.

Table 2
Predictions about interaction effects between the stated attitudes of the respondents and the use of tax revenues.

Attitudinal variable	Chosen category	Use of revenue	H_1	H_0
Would benefit personally from earmarking for income redistribution	Fully agree	Redistribution	$H2A_1$: $\beta>0$	$H2A_0$: $\beta=0$
	Partly agree	Redistribution	$H2A_1$: $\beta>0$	$H2A_0$: $\beta=0$
	Partly disagree	Redistribution	$H2A_1$: $\beta<0$	$H2A_0$: $\beta=0$
	Fully disagree	Redistribution	$H2A_1$: $\beta<0$	$H2A_0$: $\beta=0$
Would benefit personally from earmarking for environmental measures	Fully agree	Environment	$H2A_1$: $\beta>0$	$H2A_0$: $\beta=0$
	Partly agree	Environment	$H2A_1$: $\beta>0$	$H2A_0$: $\beta=0$
	Partly disagree	Environment	$H2A_1$: $\beta<0$	$H2A_0$: $\beta=0$
	Fully disagree	Environment	$H2A_1$: $\beta<0$	$H2A_0$: $\beta=0$
"The government makes reasonable use of the income [revenue] from taxes and fees."	Fully agree	Redistribution	$H2B_1$: $\beta<0$	$H2B_0$: $\beta=0$
	Partly agree	Redistribution	$H2B_1$: $\beta<0$	$H2B_0$: $\beta=0$
	Partly disagree	Redistribution	$H2B_1$: $\beta>0$	$H2B_0$: $\beta=0$
	Fully disagree	Redistribution	$H2B_1$: $\beta>0$	$H2B_0$: $\beta=0$
"The government makes reasonable use of the income [revenue] from taxes and fees."	Fully agree	Environment	$H2B_1$: $\beta<0$	$H2B_0$: $\beta=0$
	Partly agree	Environment	$H2B_1$: $\beta<0$	$H2B_0$: $\beta=0$
	Partly disagree	Environment	$H2B_1$: $\beta>0$	$H2B_0$: $\beta=0$
	Fully disagree	Environment	$H2B_1$: $\beta>0$	$H2B_0$: $\beta=0$
"In order for fuel taxes to have an environmental effect it is crucial that the tax income [revenues] are earmarked for env. measures."	Fully agree	Environment	$H2C_1$: $\beta>0$	$H2C_0$: $\beta=0$
	Partly agree	Environment	$H2C_1$: $\beta>0$	$H2C_0$: $\beta=0$
	Partly disagree	Environment	$H2C_1$: $\beta<0$	$H2C_0$: $\beta=0$
	Fully disagree	Environment	$H2C_1$: $\beta<0$	$H2C_0$: $\beta=0$

scale. One such statement was: "In order for fuel taxes to have an environmental effect it is crucial that the tax revenues are earmarked for environmental measures." The statement intended to measure the level of trust in government spending decisions read: "The government makes reasonable use of the income [revenue] from taxes and fees." Finally the respondents were asked to indicate to what extent they expected to benefit personally from the three forms of revenue use; unspecified, earmarked for income redistribution, and earmarked for environmental measures. These variables are indicators of the attitudes of the individuals.[6] Dummy variables indicating the answers people chose to the attitudinal questions are interacted with the variables describing the options in the choice experiment. These interaction variables are entered as fixed rather than random parameters.

We have now specified all the variables that will be used to test our hypotheses as to why earmarking increases support for fuel taxation. Hypothesis 2A posits that earmarking is popular because voters expect to benefit personally from the use of the earmarked revenues. To investigate this claim, we created interaction variables between — on the one hand — each of the earmarking dummies, and — on the other hand — the stated expectation of personal gain from the form of earmarking in question. The hypothesis predicts a positive interaction effect for those who state that they expect to gain, and a negative interaction effect for those who do not. This is formalized in Table 3. The first column lists the attitudinal question that forms part of the interaction. The second column lists the choice alternatives for this question — each of which becomes a dummy variable. The most neutral alternative (neither agree nor disagree) is omitted in each case and becomes the reference category. The third column lists the attribute of policy that forms the second part of the interaction, and the last column states the prediction to be tested.

The next alternative explanation to be tested is H2B, which states that earmarking increases the acceptability of taxes because of distrust in government spending decisions. This hypothesis implies that those who are most distrustful of such decisions, should show the strongest preference for earmarking, see Table 3. The final hypothesis — H2C — holds that earmarking for environmental purposes is popular because it increases the perceived environmental effectiveness of the tax. This implies that earmarking for environmental purposes is more important to people who agree with the statement that such earmarking is crucial for the tax to have an effect on the environment, than to people who disagree, as formalized in the bottom part of Table 3. This hypothesis also implies that voters on average prefer earmarking for environmental purposes over earmarking for income redistribution:

$H2C_1$: $\mu(\text{environment}) \geq \mu(\text{redistribution})$
$H2C_0$: $\mu(\text{environment}) = \mu(\text{redistribution})$

When conducted on the entire sample, the above test is, however, not sufficient to draw any conclusions regarding the hypothesis. Rejection of the null hypothesis could arise also if voters have a stronger preference for government spending on the environment per se relative to spending on income redistribution. Therefore, we will perform this test on coefficients estimated from a subsample, defined by a low stated concern for the environmental (climate change) effects of automobile use, and a high stated concern for income redistribution. If these voters prefer earmarking of fuel taxes for environmental purposes over income redistribution, it would provide strong support for H2C.

4. Results and Discussion

In total, 1250 people responded to the survey which implies a response rate of 45%. Out of those, 1177 completed the entire survey. The option do not know/cannot answer was chosen in 10% of the total number of tasks. These responses were excluded from the analysis. We checked whether this introduced any bias in the estimated preferenced through a weighting procedure described in the next section. Thirty respondents chose this option for every choice set, and are not included in the estimations. This leaves 1147 usable responses.

Table 3
Summary of descriptive statistics.

Variable	Statistic	Population	Sample
Gender	% female	50.00	49.70
Northern Norway	% of total	9.58	11.30
Middle Norway	% of total	8.69	9.26
Western Norway	% of total	26.00	24.81
Southern Norway	% of total	5.74	5.95
Eastern Norway	% of total	49.98	48.68
Age (years)	Mean	39	46

[6] Ideally, such variables such would be treated as latent variables, which would require the construction of a hybrid choice model combining a latent class model with a RUM (Ben-Akiva et al., 1999; Ben-Akiva et al., 2002a; Ben-Akiva et al., 2002b), to avoid potential problems of endogeneity. However, since we are interested only in testing whether these variables have any predictive power or not, rather than in the absolute sizes of their coefficients, we opt for the simplicity of including them directly in the utility function, like in e.g. Koppelman and Hauser (1978), and Harris and Keane (1998).

Table 4
Main regression results.

Variable		Model 1			Model 2		
		Coefficient	Std. err.	t-value	Coefficient	Std. err.	t-value
Tax rise	Mean	−1.6338	0.0885	−18.46	−1.6917	0.1567	−10.79
	Std. deviation	1.3763	0.0845	16.28	1.4503	0.1612	9.00
Redistribution	Mean	0.7953	0.1204	6.60	0.8107	0.1528	5.30
	Std. deviation	2.4791	0.1806	13.73	2.5622	0.2972	8.62
Environment	Mean	2.9791	0.1578	18.88	3.2369	0.2933	11.04
	Std. deviation	2.6082	0.1872	13.93	2.6407	0.3268	8.08
Zero tax rise	Mean	1.7734	0.1727	10.27	–	–	–
	Std. deviation	3.1613	0.2157	14.66	–	–	–
No. of choice sets analyzed			7908		3590		
Log likelihood			−3189.95		−1593.69		
Likelihood ratio chi-square (DF)			1768.1 (4)		321.96 (3)		
Likelihood ratio index			0.418		0.360		

Table 4 can be used to check for self-selection effects in terms of gender, age and region. It shows that the final sample is a good representation of the population of Norwegian voters with respect to these variables. The reason for the difference between the sample and population values for mean age is that people below the age of 18 were excluded from the sample (as 18 is the voting age in Norway).

4.1. Treatment of Potential Protest Responses

A general problem in stated preference studies is that some respondents might cast their responses to signal disapproval of the question rather than giving the response that best reflect their preferences. In this survey, people were in many choice tasks asked to choose between two different proposals that would both raise the tax on fuels. There is a potential risk that respondents who do not favor a tax increase could reject such a choice. We took three measures to mitigate the risk that such reactions would influence our results and the analysis. First, the instructions state that "if you do not like any of the alternatives, it is important that you tick off for the alternative you oppose the least". Second, a non-response option (*do not know/cannot answer*) was included in each choice task, to avoid those who strongly oppose taxes to self-select themselves out of the entire survey. Third, we used the data on non-responses in combination with responses to a different question gaging the attitudes towards fuel taxation in order to create weights to compensate for strong opponents choosing the non-response as a protest. This question was "if there was a referendum today on what should happen to the fuel taxes, i.e. the taxes on gasoline and diesel, which alternative would you vote for?" The respondents could choose between the options removing the taxes, decreasing the taxes by NOK 1/l, no change, increasing the taxes by NOK 1/l, and doubling the current tax rates. Based on which of the five categories they chose for this question, respondents were given a weight in the analysis of the choice experiment results according to the following formula, which is an adaptation of the standard procedure for weighting respondents, outlined in e.g. De Vaus (2002):

$$\frac{1-\%\ of\ non-reponses\ within\ this\ category}{1-\%\ of\ non-responses\ in\ sample}. \quad (2)$$

Table 5
Compensating variations derived from estimated coefficients.

	Alternative is no taxrise		Alternative is positive taxrise	
	Redistribution	Environment	Redistribution	Environment
Mean	−0.599	0.738	0.487	1.823
Lower limit	−0.839	0.526	0.342	1.626
Upper limit	−0.359	0.950	0.631	2.021

Those who chose the option of removing existing taxes were slightly overrepresented among non-respondents in the choice experiment and were assigned a weight of 1.04. The weighting did not lead to any substantial changes in the estimates, and we will therefore report the unweighted estimates.

4.2. The Effect of Earmarking on Support for Fuel Taxation

The results of the regression support our hypothesis 1A that voters on average prefer lower fuel taxes. As can be seen from Table 5, testing the corresponding null hypothesis yields a t-value of 18.5, which implies rejection at every conventional level of confidence. Hypothesis 1B — that earmarking increases support — is also supported. The coefficients for both types of earmarking are positive and significantly different from zero at all conventional levels of confidence.[7]

The large and statistically significant coefficients for the standard deviations suggest that there is substantial heterogeneity in voters' preferences for fuel taxation and earmarking. However, we note that, as pointed out by e.g. Louviere et al. (2002), part of the variation observed may be due to differences in the variance of the error term, rather than preference heterogeneity. We are therefore cautious of making strong conclusions about the heterogeneity in the preference parameters.

The large and significant coefficient for the *zero tax rise dummy* indicates that responses displayed a strong status quo effect. The status quo effect refers to a consistent observation in behavioral and experimental economics that an alternative is more likely to be chosen when it is perceived as the status quo than when it is perceived as an alternative to the status quo (see for example Tversky and Kahneman, 1991). In our results it is embodied as larger difference in preferences between zero increase and a NOK 1 increase than between a NOK 1 increase and a NOK 2 increase. If there were no status quo effect, one would expect the coefficient of the *zero tax rise dummy* to be close to zero, as the use of revenues from the current fuel tax is unspecified, and the reference category for use of increased revenue is also *unspecified*. To check whether the status quo effect has been adequately captured by the *zero*-dummy, we also estimate a model where we omit all observations where *tax rise* equals zero (Model 2), the results of which are also included in Table 5. The absolute sizes of the coefficients change slightly relative to Model 1, but it is actually only the relative sizes of the coefficients that have any meaning, and these change less than the absolute values since the changes go in the same direction for

[7] An alternative regression was run where all the random coefficients are specified to have triangular distributions, with bounds estimated from the data, using Train (2006). This does not change any conclusions and the changes in the coefficients are minor. We will focus on the results from the estimation using the module developed by Hole (2007a), with normal distributions, due to the greater range of postestimation tools offered with this module.

Table 6
Tests of predictions presented in Table 2.

Attitudinal variable	Chosen category	Attribute of policy		Coefficient	t-value	p-value
		Tax rise	Mean	1.702	−18.750	0.000
			Std. dev.	1.454	14.88	0.000
		Redistribution	Mean	1.108	3.990	0.000
			Std. dev.	1.748	−10.250	0.000
		Environmnet	Mean	0.890	1.950	0.051
			Std. dev.	1.672	−10.25	0.000
		Zero tax rise	Mean	1.497	10.680	0.000
			Std. dev.	−2.509	−13.04	0.000
I would benefit personally from earmarking for income redistribution	Fully agree	Redistribution	Mean	3.215	9.240	0.000
	Partly agree	Redistribution	Mean	1.112	4.140	0.000
	Partly disagree	Redistribution	Mean	−0.840	−2.750	0.006
	Fully disagree	Redistribution	Mean	−2.191	−7.090	0.000
I would benefit personally from earmarking for environmental measures	Fully agree	Environment	Mean	2.382	7.530	0.000
	Partly agree	Environment	Mean	0.666	2.010	0.044
	Partly disagree	Environment	Mean	−0.281	−0.600	0.551
	Fully disagree	Environment	Mean	−1.386	−2.290	0.022
"The government makes reasonable use of the income [revenue] from taxes and fees."	Fully agree	Redistribution	Mean	−0.233	−0.480	0.631
	Partly agree	Redistribution	Mean	−0.166	−0.560	0.572
	Partly disagree	Redistribution	Mean	−0.760	−2.540	0.011
	Fully disagree	Redistribution	Mean	−1.324	−3.750	0.000
"The government makes reasonable use of the income [revenue] from taxes and fees."	Fully agree	Environment	Mean	0.230	0.420	0.671
	Partly agree	Environment	Mean	−0.335	−1.110	0.268
	Partly disagree	Environment	Mean	−0.971	−3.180	0.001
	Fully disagree	Environment	Mean	−1.451	−4.140	0.000
"In order for fuel taxes to have an environmental effect it is crucial that the tax income [revenues] are earmarked for env. measures."	Fully agree	Environment	Mean	1.766	5.080	0.000
	Partly agree	Environment	Mean	1.240	3.560	0.000
	Partly disagree	Environment	Mean	−0.392	−0.860	0.392
	Fully disagree	Environment	Mean	−0.369	−0.690	0.487
No. of choice sets analyzed				7908		
Log likelihood				−2952.58		
Likelihood ratio chi-square (4)				1353.04		
Likelihood ratio index				0.461		

all the coefficients. In summary, there seems to be a strong status quo effect in the results, but our model is able to adequately incorporate it.

The table also reports the standard measure of goodness of fit for logit models, the likelihood ratio index, also known as McFadden's pseudo R^2.The values obtained indicate that the models fit the data quite well.

The absolute values of the estimated coefficients have no intuitive interpretation. However they can be used to derive a welfare measure of a policy change that is consistent with economic theory. We define the cost of a fuel tax policy to a representative voter as the increase in the tax rate. Now consider two policy proposals, policy 0 increases the tax rate by some amount x with no earmarking, while policy 1 increases the tax rate by the same amount x with the additional revenues earmarked to a given cause. The amount by which the tax rate would have to increase in policy 1 over and above x in order to make the representative voter indifferent between the two policies is called the compensating variation (CV) for the earmarking. It can be calculated according to the following formula adapted from Hanemann (1984):

$$CV = -\beta_{tax}^{-1} \ln\left[\frac{\sum_i \left(V_i^1\right)}{\sum_i \left(V_i^0\right)}\right] \tag{3}$$

where β_{tax} is the coefficient of *tax rise*, V^0 represents the utility of the tax rise of x with no earmarking, and V^1 represents the utility of a tax rise of x with earmarking. If one assumes utility is a linear function of the tax increase, the above equation simplifies to the ratio of coefficients given in Eq. 4 where β_{ear} is the coefficient the dummy variable for the relevant type of earmarking:

$$CV = \frac{-\beta_{ear}}{\beta_{tax}} \tag{4}$$

We will use this formula when comparing an earmarked increase with a non-earmarked increase. When comparing an earmarked tax rise with the status quo, we must account for the discontinuity in the utility function where the tax increase is zero. The formula then becomes:

$$CV = \frac{-(\beta_{ear} - \beta_{zero})}{\beta_{tax}}. \tag{5}$$

When using the mean values for the coefficients, the formula estimates the tax rise that would make the average voter indifferent between an earmarked increase and the status quo. Table 6 reports the compensating variations derived from the different models, both relative to a non-earmarked increase and relative to the status quo. To derive the confidence intervals, we have employed the delta method (Oehlert, 1992).[8]

The analysis suggests that the average voter would support a tax increase of up to around NOK 0.74 if the additional revenues were earmarked for environmental measures, which is equivalent to an increase of around 15% relative to the current level. This is a strong result, since the respondents prefer to reduce the taxes *per se*. In contrast, earmarking for income redistribution does not increase support sufficiently to make any tax increase acceptable to the average voter (indicated by the negative value for the CV).

If the government had decided to increase the fuel tax in any case (i.e. excluding the status quo effect), the results suggest that the average voter would be indifferent between a non-earmarked tax rise of a given amount and a tax rise around NOK 1.82 higher than that given amount with the additional revenues earmarked for

[8] This has been shown to be the most accurate method for these types of calculations when the data is well conditioned (Hole, 2007b). The Krinsky–Robb procedure (Krinsky and Robb, 1986) is also frequently employed in the literature and is more robust to model misspecifications and noisy data Hole, 2007b). We therefore performed also this procedure, but none of the limit values change by more than NOK 0.02. This is consistent with Hole's, 2007b observation that the methods produce fairly similar confidence intervals.

environmental measures. Earmarking for income redistribution would only increase support to compensate for around NOK 0.49 of a tax rise.

4.3. Why does earmarking increase the acceptability of fuel taxes?

The results from the regression including interactions with individual-specific variables are shown in Table 7. They indicate that there is a relatively stable relationship between stated expectations of personal gain from earmarking and preferences for such, as postulated by H2A. Seven of the eight predictions from this hypothesis are supported at the 5% confidence level or lower. If we look at the frequencies of responses to the questions about expected personal gain from the different forms of revenue use — presented in Table 8 — we find that this ranks the types of revenue use in the same order as the RUM produced. Hence it appears that part of the appeal of earmarking can be explained by an expectation that it will be in the voters' self-interest.

The hypothesis that the appeal of earmarking can be explained by a lack of trust in government spending decisions (H2B), is not supported by our data. None of the null hypotheses associated with this hypothesis can be rejected. Actually we find that respondents who stated the strongest distrust in government are significantly *less* in favor of earmarking than the reference group, i.e. the coefficients have the opposite sign of that predicted by H2B (implying outright rejection of two of the predictions of H2B). One explanation for this somewhat surprising result could be that those who distrust government spending decisions would also distrust a pledge to earmark funds.

The third and final hypothesis, stressing the importance of the link between the taxed activity and the spending cause, finds strong support in the data. The four coefficients associated with this hypothesis have the predicted sign and ordering. Two of the coefficients are not significantly different from zero, but this may be because of a low number of respondents choosing the relevant response categories. In fact only 10% of the sample partly or fully disagreed with the statement "in order for fuel taxes to have an environmental effect it is crucial that the tax income [revenues] are earmarked for environmental measures", while a full 80% of respondents partly of fully agreed with the statement. This observation is in itself consistent with hypothesis H2C. The hypothesis also predicts that the coefficient for earmarking for environmental measures would be larger than that for earmarking for income redistribution. We have seen that this is the case for the sample as a whole, but we also test the assumption within the subsample of respondents who stated little or no concern for the effects of driving on climate change and a high level of concern for potentially negative distributional effects of fuel taxation. A Wald test of the null hypothesis that $\mu(\text{environment}) = \mu(\text{redistribution})$ within this subsample of 380 respondents gives a chi-square value of 21.50, implying that the null hypothesis can be rejected at all conventional levels of significance in favor of the alternative hypothesis that $\mu(\text{environment}) > \mu(\text{redistribution})$. This is also consistent with the fact that in practice there is a clear tendency for tax revenue to be earmarked for a purpose directly related to the tax-liable activity: environmental taxes are earmarked for environmental purposes (OECD, 2010).

5. Conclusions

We have explored two research questions and tested five hypotheses. The primary research question concerns to what extent earmarking can increase support for raising the fuel tax rate. We find support for both related hypotheses — that people prefer lower fuel taxes (H1A) and that earmarking increases public support for fuel taxation (H1B). More specifically, our results suggest that there is a majority for increasing the current fuel tax rate in Norway by around 15% if the additional revenues generated are earmarked for environmental measures.

Our secondary research question concerns *why* earmarking increases public support for fuel taxes. We tested three hypotheses relating to theories about why earmarking increases acceptability. We find support for the hypothesis that earmarking increases acceptability because people expect to benefit personally from the use of the earmarked revenues (H2A). We find strong support for the issue-linkage hypothesis, i.e. that earmarking increases acceptability because people are concerned about the environmental effectiveness of the tax, and do not believe that the tax will improve environmental quality without earmarking (H2C). Those who do not understand that environmental taxes per se can improve the environment, show a stronger preference for earmarking. We reject, however, the hypothesis that earmarking increases acceptability of increased taxes because of distrust in government spending of revenues (H2B). Our results show that those who distrust the government do not favor earmarking more strongly than those who trust it, in fact they are significantly less in favor of it. Another illustration of this somewhat surprising result is that whereas earmarking for environmental taxes makes it acceptable to the majority to increase the fuel tax rate, earmarking for income tax does not, although it is still preferred over no earmarking. These two results combined suggest that the thematic link between taxing and spending is more important than the reduced uncertainty over what the revenues are spent on.

Our study suggests that earmarking revenues for environmental purposes can be an attractive second-best policy option in the face of public opposition to environmental taxation. The reasons seem to be that it raises the *perceived* environmental effectiveness of the tax, and that people expect to benefit personally if revenues are earmarked for environmental purposes. Whether this surprising result holds for other countries than Norway remains to be tested.

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Table 7
Frequency distributions for questions about expected personal gain from different uses of revenue (percentage of sample).

	I would benefit personally from general fund financing or reduction of other taxes	I would benefit personally from earmarking for income redistribution	I would benefit personally from earmarking for environmental measures
Fully agree	8.5	12.3	51.5
Partly agree	18.6	23.1	28.3
Neither agree nor disagree	26.4	27.7	11.0
Partly disagree	21.7	16.3	5.3
Fully disagree	24.8	20.6	3.9

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Appendix A. Text Explaining the Choice Experiment to Respondents

In the next twelve questions, we ask you to choose between different alternatives for what can happen to the fuel tax, i.e. the tax on gasoline and diesel. For each alternative, we state by how much the tax will increase in terms of *kroner* and *øre* [the Norwegian monetary units] (alternatively no increase), and what the government will spend the additional tax revenues on. There are three alternatives for how the revenue from the tax rise can be used:

- Unspecified, i.e. the revenues are used to cover the government's general expenses or to lower other taxes and fees.
- Earmarked for environmental measures, i.e. supporting public transport, construction of bicycle and footpaths, noise screening, and development of clean technologies
- Earmarked for income smoothing. The tax revenues are used to lower the income tax in a way that benefits primarily low-income households.

For the alternative "no change" in the tax, there will be no additional tax revenues to distribute.

We ask you to tick for the alternative you would prefer. There are no correct or incorrect responses. If you do not like any of the alternatives, it is important that you tick off for the alternative you oppose the least. You will always have the opportunity to go back and change your response if you change your mind.

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