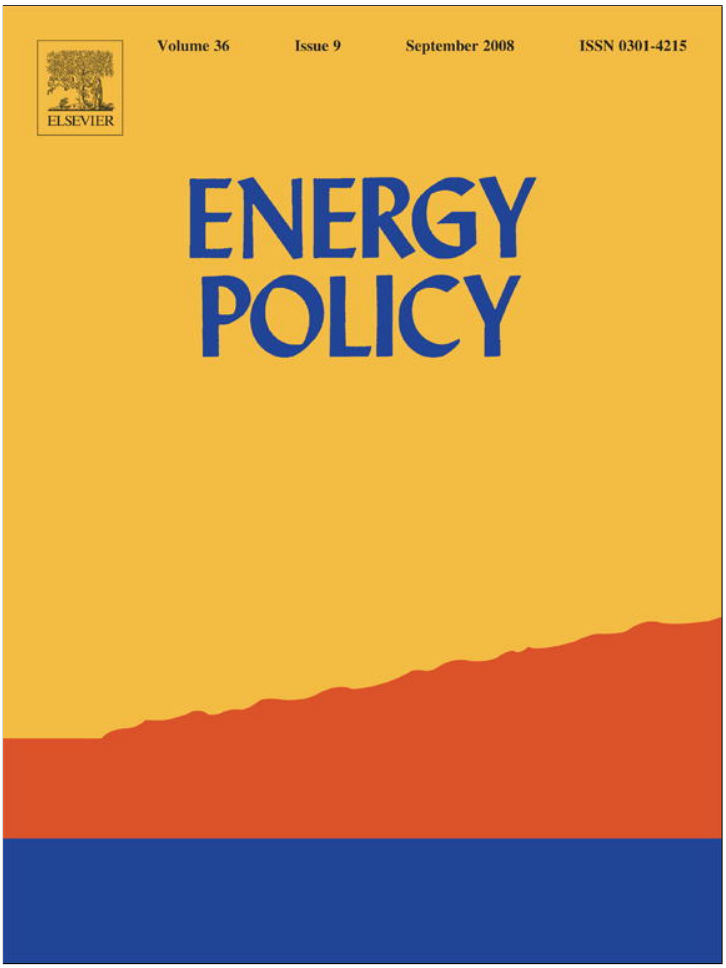

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Pollution tax heuristics: An empirical study of willingness to pay higher gasoline taxes

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ABSTRACT

Economists widely agree that in concept, pollution taxes are the most cost-effective means of reducing pollution. With the advent of monitoring and enforcement technologies, the case for pollution taxation is generally getting stronger on the merits. Despite widespread agreement among economists, however, pollution taxes remain unpopular, especially in North America. Some oppose pollution taxes because of a suspicion that government would misspend the tax proceeds, while others oppose pollution taxes because they would impose economic hardships upon certain individuals, groups, or industries. And there is no pollution tax more pathologically hated as the gasoline tax. This is unfortunate from an economic perspective, as a gasoline tax is easy to implement, and is a reasonable Pigouvian tax, scaling proportionately with the harms of consumption. Surprisingly, there is a dearth of theory explaining this cleave between economists and virtually everybody else. Drawing on behavioralist literatures, this paper introduces several theories as to why people and governments so vehemently oppose pollution taxes. Using the example of gasoline taxes, we provide some empirical evidence for these theories. We also show that "revenue recycling," the use of tax proceeds to reduce other taxes, is an effective means of reducing opposition to gasoline taxes.

1. Introduction

Economists almost universally agree that in concept, pollution taxes are the most cost-effective means of reducing emissions of pollution (see, e.g., Baumol and Oates, 1988; Dasgupta and Heal, 1979; Izzo, 2007; Mankiw, 2006; Sitglitz, 2006). As long as monitoring and administrative costs are low, a pollution tax equivalent to the marginal social cost of pollution yields a welfare-maximizing equilibrium (Tietenberg, 1992). Of course, it is not necessarily true that measurement and administrative costs are low, in which case pollution taxes may be inferior to "command-and-control" means of controlling pollution, which mandate specific abatement measures (Cole and Grossman, 1999). But with the advent of various monitoring and enforcement technologies and techniques, the case for pollution taxation is generally getting stronger on the merits.

Despite widespread agreement among economists, however, pollution taxes remain widely unpopular, especially in North America. A number of economists from a variety of political perspectives have called for a carbon tax to reduce emissions of greenhouse gases (see, e.g., Mankiw, 2006; Sitglitz, 2006), but the carbon tax idea has remained politically unpopular (Hsu, 2008). Gasoline taxes, in particular, are a form of pollution tax that have been politically dangerous to propose (Nivola and Crandall, 1995), despite even stronger support from economists (Mankiw, 2006). A survey of 40 leading US economists found little agreement regarding which of 13 national tax and regulatory reform programs were desirable as public policies, with the exception of unanimous support for a 25 cents per gallon fuel tax increase (Wachs, 2003).

From an economic perspective, the pathological hatred of gasoline taxes is unfortunate because gasoline taxes are easy to implement. For one thing, gasoline taxes are already routinely collected at the pump, so no additional administrative or monitoring costs need to be absorbed. Second, a per-quantity-of-gasoline tax is strongly correlated with the amount of pollution emitted during motor vehicle operation. While motor vehicles vary in the rate at which they spew pollution, the greatest determinant of most motor vehicle pollutants is the number of vehicle miles traveled (Nivola and Crandall, 1995). In particular, carbon dioxide emissions and quantity of gasoline consumed is highly correlated, since carbon dioxide emissions is largely determined by vehicle miles traveled and vehicle weight, which both scale with gasoline consumption (USEPA, 2005; UNEP, no date).

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This article explores the possibility that certain heuristics prevent people from being able to objectively evaluate the merits of gasoline taxes as a pollution reduction and energy savings program. In other words, we empirically investigate the hypothesis that cognitive gaps in reasoning, and not rational decision-making processes, account for much resistance to gasoline taxes. At the same time, we test for certain household economic factors that previous studies have suggested may also explain political resistance to gasoline taxes (Hammar et al., 2004). There has been little empirical analysis in these areas, and no study that we are aware of simultaneously considers both of these types of explanations.

1.1. Resistance to gasoline taxes

Resistance to gasoline taxes has a number of demonstrated sources. Studies from Germany, Denmark, Ireland, France and the UK have demonstrated that some resistance to pollution taxes derives from the fact that the public does not trust politicians to spend environmental taxes solely on environmental measures (Beuermann and Santarius, 2006; Clinch and Dunne, 2006; Deroubaix and Lévèque, 2006; Dresner et al., 2006; Klok et al., 2006). Some resistance is also likely related to issues of tax distribution. There is concern that poorer members of society will be disproportionately affected by pollution taxes (Clinch and Dunne, 2006; Dresner et al., 2006; Klok et al., 2006) or that such a tax burden will be unfairly distributed (Beuermann and Santarius, 2006). Energy intensive industries also fear that they would bear the brunt of any pollution taxes (Clinch and Dunne, 2006; Deroubaix and Lévèque, 2006; Klok et al., 2006). One political economy theory is that high levels of gasoline consumption create a large political constituency that naturally opposes higher gasoline taxes (Hammar et al., 2004). The North American built environment, heavily tilted towards automobile transport, would thus naturally be a hostile place for higher gasoline taxes, creating a positive feedback loop, in which low gas prices have begotten high gasoline consumption, which begets strong political opposition to high gasoline taxes.

There are also, however, some more subtle psychological effects that affect the acceptability of gasoline tax increases. In general, people tend to oppose "push" measures, such as gasoline taxes, or congestion fees, which seem more coercive, but tend to support "pull" measures, such as subsidies for transit or facilities for cyclists (see, e.g. Eriksson et al., 2006; Holzer, 2003; Rienstra et al., 1999; Schade, 2003; Steg, 2003; Steg and Vlek, 1997). People generally oppose push measures even if they agree with the intended aims of the measure (Baron, 1995; Baron and Jurney, 1993), and even perceive that pull measures are more effective than push measures in changing behavior (Steg and Vlek, 1997), despite the demonstrable fact that the opposite is true (Gomez-Ibanez and Small, 1994). Perceived fairness influences the acceptability of a measure (Bamberg and Rölle, 2003; Eriksson et al., 2006; Fujii et al., 2004; Ittner et al., 2003; Jakobsson et al., 2000; Joireman et al., 2001; Jones, 2003; Schlag and Teubel, 1997), and measures requiring payment for something that was previously free are perceived to be unfair are unpopular (Eriksson et al., 2006; Fujii et al., 2004, Schuitema, 2003; Schlag and Teubel, 1997). Regressivity is an often-cited reason for rejecting gasoline taxes, but in reality gasoline taxes are less regressive than alternatives forms of transportation financing, such as sales taxes (Wachs, 2003).

The complicated and anomalous explanations for public opposition to gasoline taxes suggest that it would be futile to attempt to explain public attitudes towards gasoline taxes solely by economic rational actor models. A New York Times/CBS News Poll conducted in 2006 asked respondents whether they would favor a gasoline tax increase, and then immediately asked if they would favor a gasoline tax increase if "payroll taxes or income taxes were reduced." The responses were 12% in favor, 85% opposed to the first question, but jumped to 28% in favor, 63% opposed to the second. Next, respondents were asked if they would support a gasoline tax increase if it would "reduce the United States' dependence of foreign oil," and the favorability jumped to 55% in favor, 37% opposed. Finally, respondents were asked if they would support a gasoline tax increase if it would "cut down on energy consumption and reduce global warming," and favorability jumped further, to 59% in favor, 34% opposed. However, when a high dollar figure was introduced—a $2.00 per gallon—only 17% of respondents said they would favor the tax increase, while 80% would oppose (New York Times, 2006).

1.2. Overcoming resistance to gasoline taxes

The dramatic variance in these results suggests that responses to a hypothesized gasoline tax increase are highly sensitive to context. This article tests hypotheses regarding the effects of framing on the willingness of people to support a proposal to increase gasoline taxes. We provide some empirical evidence, obtained through surveying the general public, that certain framing effects have negatively affected the way that people perceive and accept the concept of gasoline taxes. Framing effects refer to the propensity for individuals to make different decisions when faced with the same choice, differently constructed, challenging traditional economic assumptions of individuals as rational actors (Tversky and Kahneman, 1981; McCaffery and Baron, 2006). There are many possible effects, but we analyze two:

First, gasoline taxes are often juxtaposed with taxes that people find more palatable, for both rational and irrational reasons. For example, people have shown a preference for sales taxes as a means of financing transportation initiatives (Hannay and Wachs, 2007). A rational reason is that people prefer more local control over tax revenues, increasing their distrust of government the further away it is (Hannay and Wachs, 2007). A less rational reason for this might be that people favor a sales tax measure because it is expressed in percentage terms, which seems smaller and more benign than one expressed in dollar terms. This is known as the *metric effect*, the propensity for respondents to perceive percentage terms differently than absolute dollar amounts (McCaffery and Baron, 2005). The expression of a gasoline tax, always expressed in terms of cents per gallon or cents per litre, allows even infrequent drivers to quickly make a rough calculation as to how much more they will pay at the pump if the gasoline tax in increased. By contrast, few shoppers are likely to be able make an informed judgment as to how much a 1% increase in sales tax will truly cost them. Framed in these terms, a gasoline tax is framed as poorly as possible for public perception purposes.

Second, some literature seems to suggest that people would rather pay for technical solutions to environmental problems than grapple with behavior-changing policy measures (Poortinga et al., 2003). In fact, the New York Times/CBS poll results (New York Times, 2006) suggest that people may even prefer paying for a technological solution to getting the money back in the form of tax relief. We test for this effect, posing to a subsample of respondents a technological earmark for the proceeds of the increased gasoline tax.

Finally, given the severe North American allergy to taxes, various pollution or carbon taxes have been suggested that propose to return the tax proceeds to taxpayers. This kind of "revenue recycling" scheme could take the form of income tax or sales tax rebates to individuals. It has long been thought that this

would overcome some political opposition to taxes (Buchanan and Tullock, 1975), and a smattering of empirical studies seem to confirm this (Harrington et al., 2001; Krupnick et al., 2001; Thalmann, 2004). Our third hypothesis is that a revenue recycling component significantly reduces opposition to a tax increase.

This last hypothesis is not one that pertains to a heuristic or psychological effect. As a practical matter, however, the increased attention on climate change and on ways of reducing greenhouse gas emissions lends some heightened importance on finding ways to introduce carbon taxes. In this context, revenue recycling has emerged as a possible policy tool to reduce some of the opposition that would face carbon taxes. We test the political feasibility of this tool.

2. Method

2.1. Participants and procedure

We conducted surveys in the Greater Vancouver, British Columbia area by approaching individuals in public places, and asking them to complete a questionnaire. Sampling locations consisted of popular public gathering places that people get to by walking, driving, biking, and taking public transportation. About two-thirds of our responses were obtained by canvassing people waiting for the popular annual HSBC Celebration of Light fireworks display in Vancouver. A total of 797 samples were obtained over a 4-week period. A small number of surveys were discarded for irreparable reasons, such as failing to answer the basic questions of whether they supported the gasoline tax scenarios.

2.2. Hypotheses

To investigate these three phenomena, we developed specific hypothesis tests.

2.2.1. Gasoline taxes are more acceptable if packaged with a revenue recycling scheme

The public generally does not support taxes or fees when revenues are allocated to general public funds (Schade and Schlag, 2003; Schuitema and Steg, 2005). Any hypothesized benefits such improved environmental quality is speculative enough and uncertain enough that they are not viewed on a par with the certain and obvious loss suffered at the gasoline pump (Steg et al., 2006). For tax or fee measures, some form of revenue recycling would be a way of negating the obvious loss that befall drivers, which one would expect would increase public acceptability (Harrington et al., 2001; Jones, 1991; Krupnick et al., 2001; Schade and Schlag, 2003). We test the hypothesis that gasoline taxes will be made more acceptable by linking them with a revenue recycling scheme. We refer to this as the "revenue recycling hypothesis."

2.2.2. A gasoline tax is more acceptable if the revenues are devoted to technological solutions to environmental problems

Revenue recycling may mollify some opponents of a gasoline tax, but some studies have indicated that people are also more willing to pay higher taxes if it will lead to some technological solution to environmental problems. For example, a recent Ipsos Reid poll found that 50% of Canadians were willing to pay an additional tax of five cents per litre of gasoline if the funds were used to fund research for "greener" fuel alternatives (Ipsos Reid, 2007). We test the hypothesis that the gasoline tax will be made more acceptable by stating revenues will be used for research projects that aim to reduce pollution. We refer to this as the "technological earmark hypothesis."

2.2.3. Revenue recycling of gasoline tax proceeds is more a more effective way of reducing opposition to gasoline taxes if expressed in absolute dollar terms rather than in abstract percentage terms

The metric effect causes people to perceive changes expressed percentage terms differently from those expressed in absolute dollars (McCaffery and Baron, 2005). Alternative revenue-raising mechanisms to the gasoline tax include sales taxes and income taxes, which are often expressed in percentage terms, while gasoline prices are expressed in absolute dollar and cent terms. Moreover, changes to sales and income taxes are usually expressed in percentage terms, while changes to gasoline prices are expressed in absolute terms. We test the hypothesis that in a revenue recycling component of a gasoline tax program, respondents will find reductions in sales taxes and income taxes to be more attractive when some additional information is provided to the respondent to help them understand how much money, in absolute terms, the reductions are likely to yield. We refer to this as the "metric effect hypothesis."

2.3. Questionnaire

The survey contained 15 questions, three of which pertained to their willingness to support gasoline taxes. The remainder of the questions sought to collect demographic information, such as age, gender, level of income and education, and transportation information, such as vehicle ownership, vehicle type, and commuting frequency and length. The three foundation questions were:

1. a gasoline tax increase of 50 cents per litre to "reduce motor vehicle pollution by reducing driving";
2. a gasoline tax increase of 50 cents per litre and a 17% reduction in income taxes; and
3. a gasoline tax increase of 50 cents per litre and a reduction in the Canadian goods and services tax, or "GST," from 6% to 3%.

Responses to each of the hypothesis testing questions were coded on the following scale: Strongly Oppose = 1; Somewhat Oppose = 2; Somewhat Favour = 3; Strongly Favour = 4. A perfect revenue recycling would return the gasoline tax proceeds to each taxpayer in proportion to their contributions, but for purposes of administering a mass survey, it was necessary to simplify the proposals as much as possible. Indeed, no reasonable revenue recycling program could perfectly return revenues anyway. There is good reason to believe, moreover, that household gasoline expenditures are correlated, to a point, with household income and household expenditures that subject to the GST (West and Williams, 2004; Poterba, 1991).

The three basic questions were varied in the way they were asked. In general, we expected to find some greater support for the gasoline tax in questions 2 and 3, than in question 1, which would support the revenue recycling hypothesis. It is important to note that we tested the revenue recycling hypothesis with the income tax reduction and GST reduction separately, as we suspected that subjects may respond differently to alterations to either tax. However, we also studied differences by varying the questions.

To test the technological earmark hypothesis, question 1 was varied by asking respondents if they support a 50-cent gasoline tax to fund "research projects to reduce pollution from motor vehicles, such as developing hybrid electric vehicle technology, hydrogen fuel cell technology, or alternative fuel sources." In pretests we found surprisingly little evidence of greater support for revenue recycling. Some post-hoc discussions with respondents revealed that they seemed particularly enamored with

technological fixes to pollution and climate change problems. We therefore made this aspect a variant, to test the hypothesis that people are more willing to support technological initiatives than measures to reduce pollution by curbing driving. This is consistent with Jakobsson et al. (2000), which found that respondents were much less supportive of measures that they perceived as "coercive," or designed to alter their behavior, than measures that were perceived as problem-solving. The aforementioned New York Times/CBS News Poll found similar results—in that when asked, "in order to cut down on energy consumption and reduce global-warming, which would you prefer—requiring car manufacturers to produce cars that are more energy efficient or imposing an increased federal tax on gasoline?" 87% of respondents said they preferred "more energy efficient cars," while only 8% said they favored a federal tax on gasoline (New York Times, 2006). This variant tested the technological earmark hypothesis.

Questions 2 and 3 were varied so that additional information was provided that gave the respondent some additional information about the rough magnitude of the tax reduction benefit that was involved. In a subsample, question 2 was posed with the additional statement that the "average Canadian household paid about $12,000 in income taxes last year, and would pay about $2000 less per year," and question 3 was posed with the additional statement that the "average household paid about $4000 in GST last year, and would pay about $2000 less per year." GST and income tax figures and the number of households, were derived from data published by Statistics Canada from the 2001 Census (Statistics Canada, 2002). These variants test the metric effect hypothesis.

Thus, testing for the revenue recycling hypothesis was within-subject, within all samples. Hypothesis testing for the other two hypotheses were between-subject, across samples.

The survey instrument also collected information on the respondent's age, gender, level of education, household income, and the first three characters of their postal code. The postal code characters were converted into a dummy variable indicating whether or not they lived in Vancouver, North Vancouver, or West Vancouver (the localities where we found the greatest support for a gasoline tax). We also collected information about the respondent's vehicle (or if they did not have one), number of kilometers driven each year, whether they used their vehicle to commute to work, and the days and distances commuted. We constructed dummy variables for whether the respondent had an SUV, or a van, or had no vehicle at all. We also constructed a variable for their weekly commute (distance of commute times days commuting), and dummy variables that sought to capture those respondents that had a "long" commute (over 25 km, over 30 km, over 50 km per week).

2.4. Analyses

All of the hypotheses were tested using difference in means tests. As the response data is most conservatively characterized only as ordinal data and not necessarily cardinal, a difference in means test might be suspect. In all cases, other tests were conducted. For the within-subject testing of the revenue recycling hypothesis, Wilcoxon matched pairs tests (Wilcoxon, 1945) were also conducted. For the between-subject testing of the other hypotheses, we also constructed ordered probit models (see, e.g. Davidson and MacKinnon, 1993; Greene, 1993; Kennedy, 2003), utilizing a sample dummy variable to conduct a z-test test for the effect of variation around the hypothesis. Also for between-subject testing, we used Mann–Whitney U-tests (Mann and Whitney, 1947). In all cases, the supplementary tests—the Wilcoxon matched pairs, the Mann–Whitney U-tests, and z-tests, yielded significance results that were very similar to those obtained by difference in means tests.

In addition to testing hypotheses, we developed ordered probit models for the purpose of finding some determinants of when individuals are willing to support an increase in gasoline taxes. We estimated ordered probit models for when: (i) proposed alone, (ii) proposed with an income tax reduction, and (iii) proposed with a GST reduction.

3. Results and discussion

Some descriptive statistics are presented in Table 1. In general, the sampled population, very representative of the population of the city of Vancouver, was slightly more affluent, had higher levels of education, drove slightly less and was more likely to have no vehicle at all than the general population in British Columbia.

3.1. Revenue recycling hypothesis

Results from the difference in means tests for the revenue recycling hypothesis are shown in Table 2 (for income tax) and Table 3 (for GST). Results for the Wilcoxon matched pairs tests are shown in Appendix A.

Overall, these results present significant evidence for the revenue recycling hypothesis, which is consistent with the little empirical work that has been done on revenue recycling (Harrington et al., 2001; Krupnick et al., 2001; Thalmann, 2004). One might be surprised that revenue recycling provides such a small "bounce" in support for the gasoline tax increase; in theory, the revenue recycling proposals would compensate respondents for their increased gasoline costs. One possible explanation is that an increase in gasoline prices triggers reactions that draw from the endowment effect, the propensity for people to attach greater value to objects in their possession than not (Tversky and Kahneman, 1981; Kahneman and Tversky, 1984). Gasoline expenditures are such a pervasive part of North American life that any increase presents itself as a very clear and certain loss, exciting in people a desire to protect what they view as the baseline wealth within their possession. To the extent a gasoline tax increase proposes a trade—higher gasoline costs in exchange for other tax benefits, the endowment effect would predict sluggish uptake of such a proposal. Investigation of this explanation is left to future research.

Table 1
Descriptive statistics

Kilometers per year driven	Percent	Highest education level	Percent
Less than 5000	39	Less than high school	2
5000–15,000	26	High school/GED	15
15,000–25,000	17	Some university	28
25,000–35,000	7	Graduated university	41
Over 35,000	6	Post-graduate degree	15
Type of vehicle for primary use	**Percent**	**Annual household income**	**Percent**
Car	50	Less than $20,000	17
Truck	5	$20,000 to $40,000	20
SUV	8	$40,000 to $60,000	18
Van/minivan	5	$60,000 to $80,000	14
Other	2	$80,000 to $100,000	9
No car	30	$100,000 to $120,000	6
		More than $120,000	14
Means of commute	**Percent**		
Driving	49		
Non-driving	49		

Table 2
Revenue Recycling Hypothesis: difference in means test, question 2 (gas tax increase vs. gas tax increase with income tax reduction)

	Gas tax increase alone	Income tax reduction
N	797	797
Mean	2.28	2.65
t-stat	−7.14	

Table 3
Revenue Recycling Hypothesis: difference in means test, question 3 (gas tax increase vs. gas tax increase with GST reduction)

	Gas tax increase alone	GST reduction
N	797	797
Mean	2.28	2.45
t-stat	−3.34	

Importantly, enthusiasm for a GST reduction appears weaker than for an income tax reduction. This was also borne out by the supplemental Wilcoxon Matched Pairs tests reported in Appendix B. One likely explanation for this is explored in Section 3.3, on the metric effect hypothesis.

3.2. Technological earmark hypothesis

Given our pre-test experiences with hypothesizing an earmark of gasoline tax proceeds to fund technological research, we tested to see whether support for the 50 cent-per-liter gasoline tax increase, with no revenue recycling, varied with whether or not we hypothesized the technological earmark. To formally test the technological earmark hypothesis, we tested for a difference in responses to question 1 in two subsamples. In one subsample, we asked respondents if they would support a gasoline tax increase "to reduce motor vehicle pollution by reducing driving," and in the other subsample we asked if they would support a gasoline tax increase "to fund research projects to reduce pollution from motor vehicles, such as developing hybrid electric vehicle technology, hydrogen fuel cell technology, or alternative fuel sources." Table 4 shows the results.

Consistent with our suspicions raised during interviews in our pre-testing phase, respondents were more willing to pay an increase gasoline tax if the proceeds would be earmarked for government funding of technological research. This result is confirmation of the difference between what seems to be a "push" measure and what seems to be a "pull" measure. In both subsamples we hypothesized exactly the same policy proposal—a 50 cent-per-litre increase in gasoline prices—and depending on whether we described the proposal as behavior-changing or funding a technological solution, respondents had a significantly different willingness to support the proposal. We were surprised that the effect of couching the proposal as a technological research funding proposal had nearly as much effect as revenue recycling into GST reductions.

3.3. Metric effect hypothesis

To test the metric effect hypothesis, one subsample varied questions 2 and 3, pertaining to revenue recycling in the form of income tax reduction and GST reduction, to contain additional information about the magnitude of the reductions. So in the latter subsample, question 2 contained the additional information that "the average Canadian household paid about $12,000 in income taxes last year, and would pay about $2000 less under this proposal." Question

Table 4
Technological Earmark Hypothesis: difference in means test, "to reduce motor vehicle pollution…" vs. "to fund technological research"

	Reduce pollution	Fund research
N	400	397
Mean	2.16	2.40
t-stat		3.29

Table 5
Metric Effect Hypothesis: difference in means test, question 2 (income tax reduction without/with additional metric information

	No add'l info.	Add'l info.
N	202	195
Mean	2.52	2.59
t-stat		0.67

Table 6
Metric Effect Hypothesis: difference in means test, question 3 (GST tax reduction without/with additional metric information)

	No add'l info.	Add'l info.
N	202	195
Mean	2.25	2.55
t-stat		2.90

3 in the latter subsample contained the additional information that "the average Canadian household paid about $4000 in GST last year, and would pay about $2000 less under this proposal." The idea was to test whether people actually had any idea of what a 17% income tax reduction meant, or what a 3% GST reduction meant. The difference in means test results are shown in Tables 5 and 6. The ordered probit model for the metric effect hypothesis and Mann–Whitney *U*-tests are contained in Appendices C–E.

It is interesting that there is a statistically significant metric effect with respect to the GST reduction (Table 6), but no difference at all with respect to the income tax reduction (Table 5). We believe that this is some evidence of the metric effect, especially since the level of support for the gasoline tax increase with revenue recycling is only significantly lower in one instance: the question concerning a GST reduction without additional information (approximately 2.25). But why is there no metric effect with respect to income tax? The most likely explanation is that respondents can do the mental calculation in their minds as to how much a 17% income tax reduction amounts to—they remember how much they paid in income taxes—but do not know how much money they pay in GST every year. Respondents might *understand* that a 17% income tax reduction is a significant amount of money, but do not comprehend the magnitude of a 3% GST tax reduction. This explanation seems particularly likely given that the willingness to pay for a gasoline tax increase and is roughly the same (approximately 2.5) in both subsamples when it comes with an income tax reduction, and in the subsample that had a GST reduction with additional metric information, suggesting that once respondents understand the payback, they had a consistent willingness to support the gasoline tax.

3.4. Determinants of willingness to support a gasoline tax increase

Hammar et al. (2004), provided evidence that there is a strong political economy component to opposition to gasoline taxes. Using a Granger causality test (Granger, 1969), Hammar et al. showed that the relationship between structural and behavioral

transportation patterns and gasoline prices have a bidirectional causal relationship. This was considered a surprising result, since most studies of gasoline prices have only assumed that gasoline prices lead to structural and transportation patterns that consume much gasoline; the reverse causal link, through political expressions, had not been previously investigated.

Given this evidence, it would be helpful to also use this data to help advance understanding of the demographic determinants of specifically which people would support a gasoline tax increase (Table 7). Ordered probit models for the purpose of finding some determinants of when individuals are willing to support an increase in gasoline taxes are set forth from left to right in Table 7 ((i) proposed alone, (ii) when proposed with an income tax reduction, and (iii) when proposed with a GST reduction).

The first model (Q1) does the best job of explaining the determinants of respondent willingness to support a gasoline tax, when not coupled with either the income tax or GST reduction. Most prominently, respondents seemed much more willing to pay an increased gasoline tax when the proceeds would be used to fund technological research. Not surprisingly, a very strong factor in the other direction was whether the respondent was a driving commuter. Those who drove to work at least once a week were much less likely to support a gasoline tax increase. Somewhat surprisingly, the commuter dummy variable was often a better explanatory variable than the weekly commuting distance, and always better than dummy variables capturing "long" (more than 25 km and more than 50 km) commuters, and a dummy variable for SUV owners. Also not surprisingly, those that did not own a car were more willing to pay a higher gasoline tax.

In other studies, household income has not typically been a strong explanatory variable, but we should not be surprised that it was a strong determinant in Model Q2, the gasoline tax increase coupled with an income tax decrease. Since the income tax decrease was stipulated to be "17%" straight across the board, those with higher incomes would benefit more than those with lower incomes. The revenue recycling would thus be a windfall for those with above-average incomes, and clearly attracts more support from that demographic.

A very interesting result was the strong statistical significance of the minivan dummy variable in Model Q3, the gasoline tax increase coupled with a GST reduction. Strangely enough, the minivan dummy variable was not significant for any other model in this study. Those respondents that drove minivans as their primary vehicle in this study (approximately five percent of respondents) were much *less* likely to support a gasoline tax increase coupled with a GST reduction. A possible explanation for this is that those with minivans typically have young children. Drivers with young children often have less disposable income, or perhaps engage in less discretionary spending, and would benefit very little from a GST break. But drivers with young children also find it difficult to transport their children without driving, so their demand for gasoline is less elastic than for the general population. The proposal put forth by question 3 thus presents a double-whammy for families with young children. More research into this question would be required before a conclusion could be drawn.

We found some evidence of demographic effects. We did not find, as Thalmann (2004) did, that age had any bearing on the willingness to support the proposal. We did find in some of our models, consistent with Thalmann, some effect of education level and some occasional effect of gender on willingness to support. With respect to educational level, we offer no better explanation than Fischel (1979), who found that there is probably some higher level of engagement with environmental issues that increases with educational level. The occasional appearance of gender as a statistically significant variable is difficult to explain, especially in light of Hayes (2001), which found no robust gender difference with respect to attitudes towards environmental issues. We can shed no light on this question.

4. Conclusions

Several points seem to emerge from this study. First, revenue recycling is generally a policy feature that improves public acceptability of a gasoline tax increase. All other things being equal, taxpayers would rather get the money back than not. This is an important finding for policy purposes, as carbon taxes are discussed to reduce greenhouse gas emissions.

Second, a very strong theme throughout the results was the appeal of funding technological research, supporting our technological earmark hypothesis. This points to the possibility that one reason for the historical lack of support for a gasoline tax is a strong and perhaps unrealistic desire that technological solutions will achieve the necessary environmental improvements without requiring any behavioral modifications. This would help explain the dominance of CAFÉ-type regulation over gasoline taxes. The problem is, of course, that motor vehicles generate many types of externalities, not just ones that can be fixed by efficiency standards or tailpipe emission improvements. The problem is exacerbated by the historical success that automakers have had in reducing tailpipe emissions *rates*. As discussed above, this has led to very little pollution reduction by motor vehicles because of the greater volume of motor vehicles, and because of a steady increase in vehicle miles traveled.

Third, another strong theme throughout all the models is the strong effect of a respondent being a driving commuter. The

Table 7
Ordered probit models for determinants of willingness to pay increased gasoline tax (Q1: when increases in gasoline taxes proposed alone; Q2: when increases in gasoline taxes proposed with an income tax reduction; Q3: when increases in gasoline taxes proposed with a GST reduction)

	Q1		Q2		Q3	
N	755		759		758	
Variable	Coeff.	*z*	Coeff.	*z*	Coeff.	*z*
Proceeds used to fund tech research (samples C and D)	0.311	3.87				
Quant info provided with tax reduction (sample D)					0.134	1.47
Commuter	−0.496	−4.76				
Weekly commuting distance			−9.86e−4	2.28	−1.71−3e	3.64
Drives minivan					−0.401	−2.04
Does not own car	0.246	2.22	0.383	4.06	0.347	3.65
Level of education (1 through 6)	0.161	3.74	0.084	1.95		
Gender (1 = female)					0.207	2.59
Household Income level (1 through 7)			0.078	3.71	0.033	1.57
Vancouver, N. Van., W. Van. resident	0.176	2.07				

commuter dummy variable was statistically significant in almost every model. In other models, the weekly commuting distance came through as more significant, but if the weekly commuting distance was replaced by the commuter dummy variable, it too, would have been significant. Clearly, the issue of gasoline prices is considerably more dear to commuters than non-commuters. On the flipside, the group of people most predictably supportive of gasoline taxes were respondents that did not own a motor vehicle. This makes sense, since a gasoline tax increase would have very little effect on these people, and revenue recycling would be a windfall for them. An important policy implication of this is that if a jurisdiction could actually get people out of their cars and turn drivers to public transit riders or bicyclists, it could change the political dynamics of gasoline taxes, in keeping with the political economy findings of Hammar et al. (2004).

Fourth, the results provide evidence of the metric effect. Respondents were more receptive to the GST reduction as a sweetener when they were given the additional information that "the average Canadian household paid about $4000 in GST last year, and would pay about $2000 less under this proposal." While some households obviously spent more and some spent less, we believe that the information provided respondents with an order of magnitude reference that impressed upon them the size of a three percent GST cut. Thus, these results provide support for the metric effect of McCaffery and Baron (2005). The policy implication of this finding is that if officials wish to increase the political acceptability of carbon taxes, a revenue recycling proposal should make clear the absolute amounts of tax reductions or rebates involved. Expressing the benefits in terms of raw percentages is not likely to be appealing to most people.

Finally, demographics matter. Certainly, household income was an unsurprisingly strong determinant of the willingness to support gasoline tax increases coupled with income tax reductions. But age, gender, level of education, and residence in one of the "greenest" jurisdictions—Vancouver, North Vancouver, or West Vancouver—matter for reasons that this study does not fully explain. This is left to future research.

An important caveat for all of these results is that respondents showed great skepticism and distrust of government. We asked respondents if they believed that the government would follow through with a plan to redistribute gasoline tax proceeds by reducing income taxes or GST, and almost *two-thirds* indicated that they did not. Clearly, Canadian government has credibility problems that would hinder its ability to sweeten a gasoline tax increase with revenue recycling, should it choose to.

A gasoline tax is a highly effective and desirable way of reducing motor vehicle emissions, most prominently carbon dioxide emissions. The lack of support in any political stakeholder group has been vexing, given the policy merits of a gasoline tax, vis-à-vis almost any other measure to reduce vehicular emissions. This study provides some clues as to why gasoline taxes have been so unpopular, and provides some guidance as to what might overcome opposition. While this article provides some psychological explanations for the sources of opposition, it also lends support to some studies that suggest there are demographic and economic components account for some opposition. Revenue recycling is clearly an important tool in the advocate's kit, but information making clear the magnitude of recycled revenues would also be helpful. As well, some effort at inducing drivers to resort to alternatives to driving, even if they achieve only modest results, may help in changing the political economy of gasoline taxes.

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Appendix A

(a) Wilcoxon matched pairs tests for revenue recycling hypothesis using income tax reductions.

N	*T*	*z*	*p*-Value
797	40,664.50	7.95	<0.01

(b) Wilcoxon matched pairs tests for revenue recycling hypothesis using GST reductions

N	*T*	*z*	*p*-Value
797	50,605.00	3.98	<0.01

Appendix B. Ordered probit model for the technological earmark hypothesis

Variable	Coeff.	*z*
Subsample dummy (hyp. test)	0.3447	4.28
Weekly commuting distance	−0.0019	−3.54
Does not own car	0.4647	4.96
Level of education (1 through 6)	0.1466	3.39
Vancouver, North Vancouver, West Vancouver resident	0.1689	1.96

Appendix C. Mann–Whitney *U*-test for technological earmark hypotheses

z	*p*-Value	*N*1	*N*2
3.16	<0.01	400	397

Appendix D. Ordered probit model for metric effect hypothesis Q2 (income tax reduction) and Q3 (GST reduction)

	Q2		Q3	
N	374		379	
Variable	Coeff.	*z*	Coeff.	*z*
Sample dummy (hyp test)	0.003	0.03	0.303	2.73
Weekly commuting distance	−0.001	−1.74	−0.002	−2.33
Does not own car	0.411	3.02	0.340	2.66
Education level (1 through 6)	0.144	2.45		
Household income level (1 through 7)	0.051	1.67		
Gender			0.214	1.88

Appendix E. Mann–Whitney *U*-test for metric effect hypothesis

Test	*z*	*p*-Value	*N*1	*N*2
Income tax reduction	0.66	0.51	202	195
GST reduction	2.74	0.01	202	195

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