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Abstract

Global climate change is of official concern at the national level throughout Europe and is mirrored in individual data. Examination of 1999 Eurobarometer survey data with respondents from 15 European countries indicates that respondents who are very worried about global warming risks are willing to increase the price of petrol by a higher percentage, if higher prices would cause less harm to the environment. Support for higher petrol prices increases with income and education, and declines steadily with age, reflecting the diminished private benefit that older respondents derive from environmental policies with deferred impacts.

Key words: global warming, climate change, willingness to pay, gasoline taxes

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I. Introduction

Global warming dominates the long-term environmental agenda, but meaningful policies will entail substantial economic sacrifice. Policies will be most effective if broadly implemented worldwide.[1] Currently, the primary proposed policy mechanism is the Kyoto Protocol, which is an international treaty designed to reduce greenhouse gas emissions. The Kyoto Protocol was ratified by the European Union and its Member States in 2002, although it has not been ratified by the United States.

While there is evident official support in Europe for climate change policies, the official views of the country may not fully reflect the preferences of the citizenry. It may be that people support international initiatives but are not willing to incur costs themselves. And, although the Kyoto Protocol has been approved by all EU countries, the strength of support may vary among the countries. In this paper we examine individual data to explore whether there are major differences across residents of these countries in their enthusiasm for such efforts and what factors determine individual support.

We use data from a 1999 Eurobarometer survey of European citizens in 15 countries. The data set provides observations on over 16,000 individual respondents and includes information on risk beliefs concerning global warming risks as well as their

[1] Aldy, Stavins, and Barrett (2003) provide a detailed qualitative review of the merits of 14 alternative policies to address global warming. These policy issues are also explored by Schelling (1997), Barrett (2003), and Stewart and Wiener (2003), among others.

willingness to incur financial costs to promote environmental quality. Respondents indicated whether they were willing to pay more for petrol if doing so would reduce harm to the environment. Our analysis focuses on three related willingness to pay variables: whether the respondent would pay more for petrol, the percentage increase that would be acceptable, and the absolute monetary cost of such an increase given petrol prices in that country. These three willingness to pay measures provide more quantifiable measures of willingness to pay than in past analyses of international data.

While gas emissions are not the only pollutant related to climate change, raising the price of gasoline has long been a prominent mechanism for reducing air pollution. Enhancement of energy efficiency has been a major concern of policies in response to the Kyoto Protocol, and gasoline taxes represent a market-based mechanism for providing incentives to reduce gasoline usage.[2] We begin with a simple model to demonstrate how willingness to pay more for petrol is affected by risk perceptions, income, and current price. Perceptions of risks of global warming should enhance support for higher petrol prices. Higher income households may be willing to pay more for improved environmental quality. If the price of gasoline is already high because of pre-existing policy efforts to reduce gasoline demand, the support for raising prices further may be diminished.

We find that slightly under one-fifth of the overall sample were willing to pay more for petrol if higher petrol prices would reduce harm to the environment. Risk perceptions, information, income, age, and education all have strong effects on willingness to pay in the expected directions. There is widespread concern about global

[2] Agras and Chapman (1999) explore the use of gasoline taxes and corporate average fuel economy standards for the U.S. to achieve compliance with the Kyoto Protocol.

warming risks, and these concerns boost willingness to pay more for gasoline. Older individuals may be less supportive of policies that impose immediate costs to them but reap primarily long-term benefits to future generations, and would only support such policies to the extent they are altruistic toward future generations.[3] Intergenerational differences are especially striking as there is a pronounced negative relationship between age and willingness to pay more for petrol so as to protect the environment. Support for such policies varies across countries in a manner broadly consistent with their exposure to the risks of climate change.

II. Conceptual Framework

The empirical analysis explores determinants of respondents' willingness to pay more for gasoline so as to foster environmental improvements.[4] Our model assumes that higher prices are achieved by imposing a tax on petrol, as taxation is the most common mechanism for increasing petrol prices. Petrol prices could of course increase for other reasons, such as requiring a reformulation of the product to be less harmful to the environment. However, the causal mechanism is not essential. What does matter is that people pay more for petrol and that doing so leads to reduced environmental harm.

There are a number of policies other than those relating to gasoline prices that can affect climate change, such as increased reliance on wind power and fuel economy requirements. However, petrol taxes have played a key role in existing environmental

[3] von Amsberg (1995) examines the intergenerational conflicts raised by such long-term policies.
[4] We note that we refer interchangeably to petrol taxes and gasoline taxes. Whether gasoline taxes or other commodity-specific taxes are an ideal policy solution from an economic standpoint has been the subject of several other analyses, such as Wijkander (1985), Fullerton and West (2002), and Richter and Schneider (2003). The focus here is somewhat different in that we address the extent to which individuals are willing to raise gasoline prices as the payment mechanism for bettering the environment. It is not the social planning issue of how the government would set gasoline taxes to promote a desired outcome.

policies and can be translated into an individual willingness to pay measure that is better defined than policy measures such as fuel economy standards. As we discuss later, the survey question on paying more for gasoline also meets many of the properties required of a valid willingness to pay measure.

Because petrol taxes have competing effects on two valued concerns, the ability to purchase gasoline-related products and the promotion of environmental quality, many of the theoretical relationships will reflect these offsetting influences. The task of the empirical analysis is to assess how people strike a balance between different valued objectives. Unlike most studies of willingness to pay for environmental amenities, individuals in our framework are not directly "buying" an environmental amenity through a cash payment. Instead the mechanism for environmental improvements is via a commodity-specific tax that would decrease petrol usage for themselves as well as for society at large. Thus there is a financial cost to themselves but also an environmental benefit that they value.

The individual chooses to impose a petrol tax t to maximize utility Z, as follows:

$$(1) \qquad \max_{t} Z = U(G(y, p(1+t))) + b(y)vE(t) .$$

Utility is a function of two items – a composite consumption commodity G that is gasoline-dependent, and a measure of environmental benefits. For simplicity the model assumes additive separability, as this simple model is sufficient to illustrate the competing effects. The first component of utility is the utility derived from consumption of the gasoline-dependent commodity, or $U(G(y, p(1+t)))$, where consumption of the commodity increases with income y and decreases with the price level p and the additional tax rate t. The prevailing value of p will already include the current level of

taxes within any given country. Thus, $G_1 > 0$ and $G_2 < 0$. The utility function U has the usual form: $U' > 0,\ U'' \leq 0$. What the model and empirical analysis seek to identify is the extent to which respondents are willing to increase these tax rates.

Note that the structure of the model in terms of tax rates has important consequences for the total willingness to pay for pollution prevention. For any given level of *t*, people with a higher level of *y* will necessarily be expressing a higher absolute value for willingness to pay than someone with a lower level of *y*. The same percentage amounts translate into greater money amounts for people with higher levels of income. Thus, even a negative relationship between *y* and the optimal *t* could imply that the total willingness to pay value increases with income, so that environmental quality could still be a normal good.

The second component of utility is the environmental benefit to the individual. The perceived environmental benefit increases with the extent of the global warming risk belief *v*. Using the policy tax mechanism *t* will increase environmental benefits measured in physical terms *E(t)* by reducing emissions so that $E' > 0$ and $E'' < 0$. To translate the expected physical benefits into a monetary metric requires a conversion factor *b(y)*. This *b(y)* value is the unit value willingness to pay for expected environmental benefits. Benefit values increase with individual income assuming that environmental benefits are a normal good, so $b' > 0$. Expected environmental benefits for the individual are consequently *b(y)vE(t)*.

The first order condition derived from equation 1 is

(2) $\quad 0 = U'G_2 p + bvE'$,

or the marginal loss in value of the composite consumption good is just offset by the marginal increased expected value of the environmental amenity. If the individual is not concerned about environmental quality, so that $b(y) = 0$, we have a corner solution in which $t = 0$ and there is no increase in petrol prices. A corner solution would also occur if people are not willing to increase the current tax rate. Note for reference below that the second order condition is

$$(3) \qquad D = U''(G_2 p)^2 + U'G_{22} p^2 + vbE'' < 0.$$

The empirical analysis estimates how the choice of some incremental tax factor t responds to the level of the perceived climate change risk v, individual income y, and the current price of gasoline p. Totally differentiating equation 2 and solving, we find that

$$(4) \qquad \frac{\partial t}{\partial v} = \frac{bE'}{-D} > 0 .$$

Increasing the perceived climate change risk v, which is the principal risk belief variable of interest, will boost the tax t people are willing to impose on themselves.

The effect of income on the optimal t is

$$(5) \qquad \frac{\partial t}{\partial y} = \frac{U''G_1 G_2 p + U'pG_{21} + vb'E'}{-D}$$

which will always be positive if $G_{21} \geq 0$. However, one might expect G_{21} to be negative since increasing the gasoline price level will reduce the role of income in purchasing the composite consumption good. Thus, greater affluence will not necessarily imply a greater willingness to incur a higher petrol tax t unless the effect of income in boosting the valuation of environmental benefits, $vb'E'$, is sufficiently great. This result is not

unreasonable because in the absence of environmental benefits, no individual would ever choose to impose a petrol tax, which can only be welfare-reducing.[5]

Finally, the base petrol price *p* will affect willingness to incur even further taxes, as

$$(6) \qquad \frac{\partial t}{\partial p} = \frac{U''(G_2)^2\, p(1+t) + U'(1+t)\, pG_{22} + G_2 U'}{-D}.$$

The effect of petrol prices on the optimal *t* depends on three component terms in the numerator, two of which are negative, and one positive. While the sign of $\partial t/\partial p$ is ambiguous in general, it will be negative unless G_{22} is very large.

III. Data Description

We use data from Eurobarometer 51.1: Environmental Issues and Consumer Associations, April – May 1999 survey.[6] The Eurobarometer surveys have been implemented since 1970 and currently query about 1000 respondents in each of the 15 European Union (EU) member countries in spring and fall of each year.[7] The surveys are used to monitor social and political attitudes, especially attitudes toward the EU, and include special topics in different waves. The Environmental Issues and Consumer Associations survey asked respondents a number of questions about the environment. Of

[5] The ambiguous effect of income on the optimal *t* parallels the earlier result by Flores and Carson (1997), who found that a positive income elasticity of demand did not necessarily imply a positive income elasticity of the willingness to pay value.

[6] Melich, Anna. Eurobarometer 51.1: Environmental Issues and Consumer Associations, April – May 1999 [Computer file.] Brussels, Belgium: INRA (Europe) [producer], 1999. 2nd ICPSR version. Ann Arbor, MI: Inter-university Consortium for Political and Social Research, 2001.

[7] These 15 countries are Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, the Netherlands, Portugal, Spain, Sweden, and the United Kingdom. East Germany and West Germany are identified separately, as are Ireland and Northern Ireland, and we analyze these as separate countries, bringing the total number of countries to 17 for the purposes of our analysis. Norway has occasionally been included in the surveys but did not participate in this survey we use here.

specific interest are questions regarding their concern and knowledge about environmental problems and their willingness to pay more for improvements in products and services that would be less harmful to the environment. Eurobarometer 51.1 has data on 16,144 individuals. After eliminating observations with missing data on the key environmental questions, we use 15,061 individual observations in the following analyses.

As indicated by our model, we estimate equations of the general form:

(7) WTP=f (risk perceptions, income, price, other characteristics).

The dependent variable is willingness to pay for an increase in the price of petrol if it would be less harmful to the environment. This value was derived from two questions on the survey. First, respondents were asked, "For which, if any, of the following products and services would you be prepared to pay a little more now so that they are less harmful to the environment?" This was followed by a list of nine items: water, food products, collecting domestic refuse, domestic refuse processing, petrol, private vehicles, heating and lighting of your home, public transport, and flights. If respondents indicated they were willing to pay more for any of the items, respondents were asked for each item they would be willing to pay more, "Would you be prepared to pay 10% more, 20% more or 30% more for it?" We focus on petrol because it is the product that the public most associates with global warming, and petrol taxes have played a key role in existing environmental policies.

We derive three measures of willingness to pay higher prices for petrol that would be less harmful to the environment. The first measure is an indicator variable equal to one if the individual would pay more for petrol, and zero if not. We also use as measures

of willingness to pay the percentage more the individual would be willing to pay, and the implied price increase per liter derived from the percentage more that the respondent was willing to pay and the actual price per liter in the respondents' country. In addition to the three options of payment of 10% more, 20% more, or 30% more, responses of "less than 10%" and "more than 30%" were recorded. To quantify the lowest category, we assign 5 percent to those willing to pay more than zero but less than 10 percent, as this is the midpoint of the range. In the following descriptive statistics, we assign 40 percent to those willing to pay more than 30 percent. As only 0.4 percent of the respondents reported that they would be willing to pay more than 30 percent, the average percentage willingness to pay is only slightly affected by this assignment of 40 percent rather than another value. We also use these percentage values in calculating the amount more the respondent would be willing to pay. In the following regression analyses we estimate the percent willingness to pay by Tobit and use the two-limit approach in the percentage increase equations in lieu of assigning any specific upper bound.

A willingness to pay question should satisfy four properties. First, it should use a credible payment mechanism. Second, there should be real opportunity costs that are apparent to respondents. Third, the willingness to pay values should satisfy basic economic rationality tests. Fourth, the commodity being purchased should be well defined and understood. As we now discuss, our measure performs reasonably well with respect to the first three properties, but is not ideal in terms of its specification of a well-defined environmental commodity. However, our willingness to pay measure is more precise than that available in other international surveys.

First, paying more for gasoline is an ideal choice for establishing a credible payment mechanism. Gasoline is a well-defined commodity that is widely used. People not only experience the price change directly, but are able to monitor these prices because they are posted. People are typically familiar with the price so are able to meaningfully respond to questions relating to price changes, and the price of gasoline varies among the countries included in the analysis, allowing us to analyze the effect of current price levels on support for increases in the price.

Second, respondents would also be aware of the opportunity costs of higher petrol prices. Not only are people generally aware that higher prices paid for petrol mean less money for other commodities, but the survey structure also made people aware of other risk and environmental causes by asking their willingness to pay for any of nine products that could be made less harmful to the environment. Thus, the focus was not exclusively on gasoline so that the survey format helps to reduce possible survey demand effects and highlights the potential resource tradeoffs across different types of expenditures. That the petrol tax imposes perceived economic costs will also be apparent from the small percentage of respondents who favor such a tax. If respondents believed that the willingness to pay response would be costless, they would be unrestrained in their stated valuations of the worthy cause of environmental improvement.

Third, a willingness to pay question should satisfy the most basic principles of economic rationality. The fundamental test is whether people are willing to pay a greater amount for larger improvements in environmental quality. For that test we will use an across subjects scope test. In particular, if people believe the risk of global warming is greater then they will be reaping a greater environmental benefit from a petrol tax and

should have a higher willingness to pay value. We also examine whether personal characteristics such as income, age, and education affect willingness to pay in a reasonable fashion.

Finally, the commodity being purchased should be well defined and understood. The commodity analyzed here is only defined generally in terms of less harm to the environment. Ideally, the survey question would have identified the specific environmental improvements that would be purchased for each higher level of the petrol price. However, the role of motor vehicle emissions and other related pollution is reasonably well understood. The survey question is useful in establishing a willingness to pay – environmental improvement linkage but cannot be used to impute a monetary value to specific environmental benefits.

Although the wording of the willingness to pay question is not ideal, it is more precise than in other international surveys providing individual data. The World Values Survey analyzed by Israel and Levinson (2004), among others, asked respondents whether they strongly agreed, agreed, disagreed, or strongly disagree with the statement, "I would buy things at 20% higher than usual prices if it would help protect the environment." While the environmental commodity is similar to that in the Eurobarometer survey that we use, the payment mechanism is not linked to specifically identifiable prices, and the survey does not offer gradations of price increases that are acceptable.[8] The 1989 Harris Survey used by Israel (2004), among others, asks respondents, "How willing would you be to pay somewhat higher taxes to the government if you knew the money would be spent to protect the environment and

[8] As a result one cannot, for example, calculate the marginal monetary amount that respondents are willing to pay for the environmental improvement.

prevent land, water and air pollution," with respondents reporting their willingness as one of four categories. This survey also lacks a well-defined payment amount and has a diffusely defined environmental commodity. The 1992 Gallup survey analyzed by Dunlap, Gallup, and Gallup (1993), among others, asked respondents, "Increased efforts by business and industry to improve environmental quality might lead to higher prices for the things you buy. Would you be willing to pay higher prices so that industry could better protect the environment or not?" This question does not specify an environmental commodity that is more precise than the Eurobarometer survey and it lacks a well-defined payment mechanism.[9]

Table 1 reports for each country petrol prices and the willingness to pay for petrol that would be less harmful to the environment. For within country petrol prices in 1999, we use the average of 1998 and 2000 petrol prices per liter in U.S. dollars.[10] As Table 1 demonstrates, both petrol prices and willingness to pay for petrol that is less harmful to the environment varies considerably among the countries, ranging from 8 percent in East Germany who are willing to pay more, to almost 33 percent in Greece. Respondents in Sweden and Denmark also show a notably high willingness to pay. One might have expected a strong warm glow effect, as there is no reason not to indicate willingness to pay for a hypothetical price increase that consumers would never have to pay.[11] Thus the

[9] Local surveys specifically studying climate change have defined the environmental good more precisely. The study by Viscusi and Chesson (1999) of coastal North Carolina businesses specified long-term storm damage risks associated with hypothetical climate change scenarios. The survey by Berk and Fovell (1999) in the Los Angeles area asked respondents, "Keeping in mind that this is a hypothetical situation, would you be willing to pay [X] dollars per month to prevent climate change here from becoming like [location]?" The survey varied the value of X and described different changes in climate.

[10] The source for fuel prices is GTZ Fuel Price Surveys, 1998, 2000 available at www.internationalfuelprices.com.

[11] More generally, there might also have been embedding effects whereby subjects used their response to indicate general support for environmental regulation. See Kahneman and Knetsch (1992) for discussion of the embedding phenomenon.

lack of overwhelming support suggests that respondents treated these possible price increases as though they would impose actual economic costs.

The last row reports the average for all observations and indicates that just under one-fifth of the entire sample are willing to pay higher petrol prices. On average people are willing to pay 2 percent more for petrol or an average of 2 cents per liter. Conditional on being willing to pay higher petrol prices, people are willing to pay 11 cents more per liter.[12]

The explanatory variables include measures of perceptions of the risk of climate change, how well informed respondents consider themselves about major environmental risks, household income, sex, marital status, education, and age. Perceptions of climate change risks are derived from a question asking respondents whether they were "very worried, somewhat worried, not very worried or not at all worried" about nine possible problems. We assigned an indicator value equal to one for respondents who reported that they are very worried about "global warming (greenhouse effect)." Other problems that the survey listed as possible concerns ranged from "urban problems (traffic in towns, noise, pollution)" to "nuclear power stations and radioactive processing," so the focus was not exclusively on risks of climate change. We use the "urban problems" variable to capture perceptions of short-term environmental risks that may be reduced by higher petrol prices, as opposed to longer-term risks associated with global climate change.

In addition to examining these two measures of perceived risks, we also analyze a measure of the degree of information that people have about environmental risks. The survey asked how well respondents were informed about "major environmental

[12] The seemingly low willingness to pay is not unlike the attitude in the U.S. as Clinton Administration proposals to impose a federal gasoline tax of 5 cents per gallon failed to receive support.

problems, like holes in the ozone layer, global warming, the disappearance of forests, etc." We assign an indicator variable equal to one for those respondents who considered themselves very well informed or fairly well informed.

Table 2 summarizes that country-specific means of these risk perception and information variables relating to the risks of climate change. As the last row in Table 2 indicates, thirty-seven percent of respondents were very worried about global warming, and 27 percent were very worried about urban problems such as traffic, noise and pollution. Just over half the sample – 53 percent – considered themselves to be very well informed or fairly well informed about major global environmental problems.

Each of these variables displays considerable variation across countries. Whereas only 22 percent of Finland respondents are very worried about global warming, 57 percent of those in Greece are very worried. Within every country, there is less concern about urban problems than about global warming. Responses range the most for the information variable, which has a low of 29 percent of those in Portugal being very or fairly well informed about major environmental problems to a high of 79 percent for Finland. Over half the sample considers themselves to be informed about major global environmental problems.

Some of the patterns across countries are surprising. The Netherlands is especially vulnerable to changes in the sea level due to global warming. Respondents there have a high degree of information about the risks but below average risk beliefs. Strikingly, residents of Finland are very well informed about the risks of climate change but are not especially worried about the risks perhaps because climate change may have some beneficial effects on northern countries. The opposite pattern is exhibited by

Greece, where respondents have a very high degree of worry about global warming, possibly due to many Greek islands at risk of flooding, but do not regard themselves as well informed. No simple pattern emerges from these countrywide mean values. There is substantial and, in some cases, unexpected heterogeneity in these variables.

We expect risk perceptions and information to be correlated with each other. People who have no information concerning the risk will not perceive any hazard so that some information is essential to trigger the perception of some risk. Once people perceive a risk, more information of a probabilistic nature will raise risk beliefs if it conveys a higher risk level than one's prior risk beliefs and will lower risk beliefs if it conveys a lower risk level. If information is of an alarmist nature and simply highlights a problem without indicating its likelihood, that information will tend to raise risk beliefs.

As for the correlation between risk perceptions and information, the data show that although there is a statistically significant correlation between information and risk perceptions of global warming, the extent of the influence is not great. Thirty-eight percent of respondents who are informed of global climate risks express worry about global warming as compared to 35 percent of those who are not well informed.

The remaining control variables are demographic characteristics. We again summarize the overall sample means of the risk perception and information variables in Table 3, and include the sample means of the demographic information. Monthly income is reported for each country in 12 categories, with an open ended topcode category. We assign the midpoint of each category, except for the topcode category. The topcode category is set equal to the minimum of that category plus half the difference of the range in the next to last category. We annualize monthly income and convert to U.S. dollars

using the exchange rate for 1999 from the Penn World Table.[13] Income is missing for almost 30 percent of the sample. We include these observations in the analysis by setting missing income to zero and include an indicator equal to one for missing values.

We also include indicator variables equal to one if the individual is male or married. Actual years of education are not recorded in the survey. Instead, respondents who had completed their full-time education reported their age of ending school full-time. We approximate years of education by subtracting five (for years before starting school) from the age of ending full-time education.[14] We set years of education at a maximum of 25 years. For those still in school, we used their current age and subtracted 5. Actual age is not reported in the survey, but is reported in categories. Most of those still in school fell into the youngest category of age 15 – 24, and we used the midpoint of this category minus 5 years and assigned 15 years of education to those respondents, with a similar assignment for those still in school in other age categories, and again topcoded education at 25 years. We assign an indicator variable equal to one to identify those still in school. The categories for age included in the regressions are age 15 – 24, 25 – 34, 35 – 44, 45 – 54, 55 – 64, and age 65 and older. The oldest age category is the omitted category in the regressions.

We also control for whether the respondent regularly checks the level of gas emissions from their car. The emissions checking variable is intended to serve as a cross

[13] Exchange rates are from Alan Heston, Robert Summers and Bettina Aten, Penn World Table Version 6.1, Center for International Comparisons at the University of Pennsylvania (CICUP), October 2002. Reported income for Denmark is apparently already annualized, as it averages $48,690 in U.S. dollars, in comparison to monthly income for all other countries of $1,769. Omission of Denmark from the analyses yields substantively similar results.

[14] The starting age for education varies across countries and also often within countries. Several countries have different ages for optional and required education start ages. Furthermore, we do not know whether respondents attended school full-time up to ending schooling full-time. Such errors in estimating years of schooling, however, are unlikely to be correlated with the variables of interest.

check on the consistency of the willingness to pay response with respondents' actual behavior. We expect people who check their emissions to be more likely to support a petrol tax.

IV. Valuation of Environmental Quality

Table 4 reports four different sets of results. The first two columns are Tobit estimates of the percentage more respondents are willing to pay for petrol so as to be more protective of the environment. Because of the large number of zeros and because the top category is not bounded but instead is "at least 30 percent," we use the two-limit Tobit procedure. The third column presents estimates of the binary decision to pay more, and the fourth column is the dollar amount more implied by the within country petrol prices and percentage more willingness to pay, also estimated by Tobit. Column 1 includes the country petrol price, while the remaining columns include country indicator variables instead of petrol price. In all columns, the coefficients have been transformed to reflect marginal probabilities.

All of the effects are identical with respect to direction and almost always with respect to significance across the specifications. Based on the probit estimates in column 3, those expressing that they are very worried about global warming are on average 4 percentage points more likely to be willing to raise the price of petrol. Those who are very worried about urban problems are also willing to raise the price of petrol, with the effect marginally significant with a p-value of 0.07 in the column 3 probit estimates, and significant at conventional levels in the 3 other equations. In each equation, the

coefficients on worry about global warming are over twice the size as the coefficients on worry about urban problems.

The positive influence of the global warming risk belief and urban problems risk belief variables accord with theoretical predictions, as perception of higher risks of environmental harm should boost the petrol tax the respondent is willing to incur. In terms of the theoretical model, people with higher values of *v* as reflected in the two environmental concern variables should favor a larger tax *t*. This result also represents an important rationality test for survey responses, as it serves as an across subjects scope test. People who perceive greater environmental risks are in effect purchasing more of an environmental commodity than those who do not perceive substantial risks. The higher tax rates favored by those who are very worried about global warming and urban problems provide evidence that the survey responses reflected the amount of the good being purchased in this hypothetical transaction.

While the influence of information on major environmental problems such as global warming is unclear theoretically because its effect depends on the nature of the information, the empirical relationship is quite strong as greater information raises the willingness to pay a petrol tax. The magnitude of the effect of being informed is comparable to that of the global warming variable, as this variable raises the probability that the person will be willing to incur a petrol tax by 0.04 in the probit estimates of Column 3, and likewise has a similar magnitude in the Tobit estimates as that on the global warming variable.

Many of the benefits of environmental improvement are deferred, so that one would expect younger respondents to exhibit a greater willingness to pay for policies that

would improve the environment. This effect is borne out as those in all of the age group categories in Table 4 have significantly greater willingness to pay than do those in the omitted age 65 and older group. The age category coefficients for the included groups also display a steady downward trend. The coefficients the age group 15 – 24 and 25 – 34 are roughly double the values for those in the age group 55 – 64.

The two income related variables are household income and education, which is a proxy for lifetime wealth. All specifications indicate that more educated respondents are more willing to pay higher petrol prices.[15] Higher income levels raise the amount of tax the respondent is willing to incur, with this finding statistically significant in the three equations estimated by Tobit, although income has only a marginal effect on the probability that an individual is willing to impose a petrol tax (p-value = 0.11.) The effect of greater affluence on the valuation of environmental benefits on balance offsets the influence of the greater total petrol cost that is borne by those who spend more on gas-related commodities. As for the other demographics, gender and marital status do not affect willingness to pay.

The emissions checking variable is intended to serve as a cross check on the consistency of the willingness to pay response with current actions the respondent takes to reduce emissions. Consistent with expectations, respondents who check their vehicle emissions are more likely to favor a petrol tax in three of the four equations.[16]

The first equation in Table 4 includes the current petrol price per liter instead of country indicators. Higher current petrol prices decrease the willingness of people to

[15] Similarly, education has a positive effect on willingness to pay in the international studies by Israel (2004) and Israel and Levinson (2004), as well as the Los Angeles study by Berk and Fovell (1999).
[16] This effect falls just short of statistical significance for the first equation in Table 4, with p-value = 0.075. Notably, those with missing values for checking vehicle emissions also exhibit positive effects in the first equation perhaps because these respondents do not own a vehicle.

boost petrol prices even higher to protect the environment. Because the base petrol price is driven by a common pricing structure in world markets, this result indicates that the existence of current taxes on petrol decreases the support for additional taxes.

Even with these extensive personal characteristic variables included, 12 of the country-specific dummy variables are statistically significant relative to the omitted country, Austria. Some of the country effects are quite large, as respondents in Greece are 24 percentage points more likely to favor higher petrol prices, and at least a 10 percentage point incremental difference exhibited by respondents in Denmark, Italy, Luxembourg, and Sweden.

V. Conclusion

International support for higher petrol prices to protect the environment reflects a mix of competing self-interests and altruism. People who perceive a greater risk of global warming and urban problems favor higher petrol prices, as one would expect. Being better informed about major environmental problems also enhances support for higher petrol prices. These results accord with theoretical prediction and also serve as a test of the rationality of responses. An additional check on the validity of the willingness to pay responses is that people who have already displayed a personal commitment to reducing air pollution by checking vehicle emissions favor higher petrol taxes. Individual income has competing effects theoretically, but on balance leads to greater support for raising petrol prices as does education, which will be correlated with lifetime wealth.

In much the same way as there are difference among countries that arise because of variations in the benefits received and the costs incurred, there are also pronounced generational differences. The oldest age group displays very little support for such efforts even after accounting for income levels and other factors correlated with age. Those in the middle age and next-to-oldest age groups also are less supportive. Because environmental policies tend to have deferred benefits, especially those related to climate change, there is an apparent generational divide as those who will benefit themselves from such long-term effects express a greater willingness to pay than those whose motives are purely altruistic.

Much of the impetus for global climate change policies has derived from the support of European countries for such measures. A substantial segment of these countries' population is very worried about global warming. These concerns are coupled with a willingness to spend more on petrol if higher prices would protect the environment. These results indicate that official levels of support for climate change policies are consistent with individual preferences within these countries.

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Table 1:
Willingness to pay more for petrol that would be less harmful to the environment

	Petrol price per liter in $US 1999, 1998 – 2000 average	Percent willing to pay more for petrol that is less harmful to environment	Percentage more willing to pay (0 to 40 percent)	Cents more per liter willing to pay if positive	Cents more per liter willing to pay – all observations
Belgium	1.04	10.7	1.10	10.69	1.14
Denmark	1.03	29.1	4.45	15.73	4.58
West Germany	0.94	12.9	1.41	10.18	1.32
Greece	0.69	32.5	4.17	8.80	2.85
Italy	1.08	22.3	2.41	11.67	2.60
Spain	0.79	15.0	1.82	9.50	1.43
France	1.05	10.1	1.06	11.04	1.12
Ireland	0.87	16.5	1.32	6.95	1.15
Northern Ireland	0.87	13.5	1.15	7.36	1.00
Luxembourg	0.77	22.1	2.30	7.96	1.76
Netherlands	1.09	21.1	2.91	15.00	3.16
Portugal	0.90	14.1	1.15	7.31	1.03
Great Britain	1.14	16.5	1.78	12.30	2.03
East Germany	0.94	8.4	0.86	9.59	0.80
Finland	1.12	18.3	2.28	13.91	2.54
Sweden	1.02	30.7	3.79	12.55	3.85
Austria	0.93	12.4	1.44	10.75	1.34
Average	0.97	18.1	2.12	11.25	2.04

Table 2: Concern about global warming and knowledge about environmental problems

	Very worried about global warming	Very worried about urban problems (traffic, congestion, pollution)	Informed about major global environmental problems
Belgium	30.1	28.0	44.8
Denmark	26.9	19.6	65.2
West Germany	38.0	22.3	57.5
Greece	57.4	48.2	35.5
Italy	42.2	35.8	58.0
Spain	36.4	30.3	31.6
France	31.0	28.0	39.9
Ireland	34.9	30.6	42.1
Northern Ireland	35.1	29.5	42.4
Luxembourg	36.1	19.6	62.8
Netherlands	24.2	17.5	73.2
Portugal	54.6	40.1	28.8
Great Britain	39.2	33.2	54.7
East Germany	31.8	23.6	57.2
Finland	22.0	14.6	79.1
Sweden	43.0	14.9	60.9
Austria	38.2	27.8	56.3
Average	36.5	27.3	52.6

Table 3: Descriptive Statistics

Variable	Percent or Mean (standard deviation)
Very worried about global warming	36.52
Very worried about urban problems	27.32
Informed about major environmental problems	52.64
Annual income if not missing ($1000 US 1999)	23.73 (16.86)
Male	47.69
Married	60.08
Years of education	13.07 (4.36)
Percent still studying	11.27
Age	
15 - 24	16.43
25 - 34	20.37
35 - 44	18.94
45 - 54	15.78
55 - 64	13.57
65 or older	14.91
Check emissions if not missing	46.69
Petrol price per liter ($US 1998-2000 average)	0.97 (0.13)
Number of observations	15,061

Table 4: Willingness to pay for petrol less harmful to the environment

	(1)	(2)	(3)	(4)
	Percent more willing to pay	Percent more willing to pay	Willing to pay more (0 – 1)	Cents more willing to pay
Very worried about global warming	0.563** (0.083)	0.464** (0.080)	0.040** (0.007)	0.458** (0.080)
Very worried about urban problems	0.232** (0.090)	0.200* (0.087)	0.013 (0.008)	0.216* (0.087)
Informed about environmental problems	0.511** (0.081)	0.474** (0.079)	0.040** (0.007)	0.467** (0.079)
Income x 10,000	0.192** (0.029)	0.068* (0.031)	0.004 (0.003)	0.068* (0.031)
Income missing	-0.122 (0.110)	-0.184 (0.112)	-0.016 (0.009)	-0.186 (0.112)
Male	-0.021 (0.078)	-0.062 (0.074)	-0.009 (0.006)	-0.064 (0.075)
Married	0.052 (0.090)	0.029 (0.086)	0.006 (0.007)	0.034 (0.087)
Education	0.090** (0.010)	0.073** (0.010)	0.006** (0.001)	0.072** (0.010)
Education – still studying	0.520** (0.152)	0.390** (0.145)	0.027* (0.013)	0.400** (0.146)
Age 15 - 24	1.277** (0.173)	1.309** (0.166)	0.098** (0.017)	1.326** (0.167)
Age 25 - 34	1.206** (0.145)	1.254** (0.140)	0.086** (0.014)	1.273** (0.140)
Age 35 - 44	0.912** (0.148)	0.960** (0.142)	0.068** (0.014)	0.982** (0.143)
Age 45 - 54	0.758** (0.154)	0.737** (0.147)	0.055** (0.014)	0.752** (0.148)
Age 55 - 64	0.628** (0.159)	0.603** (0.152)	0.050** (0.014)	0.620** (0.152)
Check emissions	0.152 (0.085)	0.309** (0.085)	0.029** (0.007)	0.310** (0.085)
Check emissions missing	0.315** (0.117)	0.183 (0.113)	0.008 (0.010)	0.209 (0.113)
Petrol price per liter	-2.054** (0.312)			
Belgium		-0.135 (0.231)	-0.006 (0.019)	-0.074 (0.232)
Denmark		2.230** (0.229)	0.149** (0.027)	2.440** (0.230)

East Germany		-0.620**	-0.051**	-0.613*
		(0.246)	(0.017)	(0.248)
Finland		0.563**	0.044*	0.744**
		(0.220)	(0.021)	(0.221)
France		-0.295	-0.021	-0.240
		(0.234)	(0.018)	(0.235)
Great Britain		0.769**	0.066**	0.950**
		(0.219)	(0.022)	(0.219)
Greece		3.440**	0.240**	2.914**
		(0.210)	(0.026)	(0.212)
Ireland		0.713**	0.080**	0.685**
		(0.227)	(0.023)	(0.229)
Italy		1.469**	0.121**	1.654**
		(0.214)	(0.024)	(0.215)
Luxembourg		1.271**	0.108**	1.113**
		(0.244)	(0.027)	(0.250)
Netherlands		1.372**	0.095**	1.589**
		(0.215)	(0.023)	(0.216)
Northern Ireland		0.293	0.039	0.266
		(0.328)	(0.031)	(0.331)
Portugal		0.537*	0.061**	0.519*
		(0.233)	(0.023)	(0.235)
Spain		0.849**	0.064**	0.721**
		(0.224)	(0.022)	(0.227)
Sweden		2.297**	0.176**	2.469**
		(0.215)	(0.026)	(0.216)
West Germany		0.064	0.007	0.072
		(0.230)	(0.020)	(0.231)
Constant	-3.989**	-6.020**		-6.070**
	(0.345)	(0.258)		(0.259)
Observations	15,061	15,061	15,061	15,061

Absolute value of z statistics in parentheses
* significant at 5%; ** significant at 1%
Columns 1, 2 and 4 estimated by Tobit, column 3 by probit. Coefficients report unconditional marginal effects.