Malapportionment, Gasoline Taxes, and the United Nations Framework Convention on Climate Change

J. Lawrence Broz
Department of Political Science, University of California, San Diego 9500 Gilman Dr. M/C 0521, La Jolla, CA 92093-0521, (858) 822-5750 jlbroz@ucsd.edu

Daniel Maliniak
Department of Political Science, University of California, San Diego, 9500 Gilman Dr. M/C 0521, La Jolla, CA 92093-0521 dmalinia@ucsd.edu

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Abstract: Gasoline taxes vary widely across industrialized countries, as does support for the United Nations' effort to address the climate change problem. We argue that malapportionment of the electoral system affects both the rate at which governments tax gasoline and the extent to which governments participate in global efforts to ameliorate climate change. Malapportionment results in a "rural bias" such that the political system disproportionately represents rural voters. Since rural voters in industrialized countries rely more heavily on fossil fuels than urban voters, our prediction is that malapportioned political systems will have lower gasoline taxes, and less commitment to climate change amelioration, than systems with equitable representation of constituents. We find that malapportionment is negatively related to both gasoline taxes and support for the Kyoto Protocol to the United Nations Framework Convention on Climate Change (where "support" is measured as the duration of the spell between the signing of the Protocol and ratification by the domestic legislature).

1. Introduction

Gasoline taxes vary widely around the world, as do efforts to join other nations in limiting greenhouse gas emissions via the Kyoto Protocol. The reasons for these variations are not obvious. For example, countries as similar in their cultural, political, and legal traditions as the United States and the United Kingdom lie at opposite ends of the spectrum in terms of gasoline tax policy and support for climate change amelioration. In this paper, we argue that political institutions help explain the variation in gasoline taxation and global warming policy. Our specific focus is on “malapportionment,” which occurs when geographic constituencies have shares of legislative seats that are not equal to their shares of population. In countries such as the United States, malapportionment has resulted in the systematic overrepresentation of rural interests. Inasmuch as rural voters depend more on fossil fuels than voters in urban districts, we expect malapportioned political systems to produce lower gasoline taxes and lower commitment to climate change amelioration than systems with more equitable representation of constituents.

Gasoline taxes influence the level of environmental externalities both nationally and internationally, but government policies do not appear to follow the pattern of an “Environmental Kuznets Curve”: countries at similar levels of economic development have very different fuel policies. Whereas the United States ($36,235 GDP per capita) and Canada ($24,925) tax unleaded gasoline at the rate of $0.10 and $0.24 per liter respectively, the Netherlands ($24,747) taxes unleaded fuel at $1.08 per liter and the U.K. ($26,864) imposes a tax of $1.10 per liter. **Figure 1** displays gasoline taxes and prices in 31 countries in year 2004. Note that pre-tax price differentials are small when compared to differences in taxes. Pretax prices range from a low of $0.39 per liter in the United Kingdom to a high of $0.49 in Norway and Japan. Thus, the total price differential between countries can be attributed almost entirely to differential taxation. For example, the tax differential between the United Kingdom and the United States is more than ten times the pre-tax price differential. Consequently, while pre-tax gas prices in the U.S. are slightly higher than in the U.K, gas prices in the U.K. are almost three times higher at the pump.

Countries at comparable levels of development also show different patterns in support for the Kyoto Protocol to the United Nations Framework Convention on Climate Change, which is aimed at combating global warming. Of the Annex 1 countries—those countries for which greenhouse gas cuts are binding—level of development explains little of the variation. In a simple bivariate regression of GDP per capita on Kyoto ratification, the results do not approach statistical significance.[1] **Figure 4** displays the duration in months between the Kyoto Protocol's inception and each Annex 1 country's ratification. Turkey's duration, the last Annex 1 country to ratify, lasted almost four times as long as Romania's duration, the first Annex 1 country to ratify, even though they are separated by only $200 in their per capita GDP. While a number of factors contribute to a country's decision to ratify the Kyoto Protocol, clearly level of development is not the main driver.

In the next section, we show that rural constituents in industrialized countries prefer lower environmental taxes than urban voters. We illustrate this point with (1) data on rural-urban differences in dependence on gasoline, and with (2) individual-level data from a large cross-national survey. In Section 3, we develop the logic of our claim that gasoline taxes (and prices) relate negatively to malapportionment. We show that countries with political systems that are more malapportioned tend to have lower gasoline taxes (and gasoline prices) than countries with systems that equitably represent voters across geographic areas. In Section 4, we

[1] This same finding holds when running a hazard model like those in Section 4 in a bivariate manner. However, as reported below, the income variable is significant when run in the fuller model.

extend our analysis to the environmental domain and evaluate the relationship between malapportionment and support for the Kyoto Protocol—the international agreement organized by the United Nations that sets targets for industrialized countries to cut their greenhouse gas emissions. Our findings confirm our expectations: in countries where malapportionment generates a rural bias in the legislature, support for the Kyoto Protocol is lower than in countries with no rural bias, all else equal. The final section concludes with an assessment of the implications of our argument.

2. Urban-Rural Differences on Environmental Taxation

Our argument develops from the idea that individual preferences for environmental taxes differ across geographic regions within industrialized countries. In developed countries, rural residents are more dependent on private vehicles for transportation; they also must travel longer distances for professional and personal purposes and the observable externalities of gasoline consumption (local air pollution, traffic congestion) affect them less.[2] All else equal, this suggests that residents of rural communities should prefer lower environmental taxes than city dwellers and be less supportive of using government tax policy to ameliorate the environmental externalities of gasoline consumption.[3]

In **Figure 2,** we use state-level gasoline consumption data from the U.S. to illustrate the differential dependence on gasoline across rural and urban communities. On the Y-axis we plot

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[2] We assume that climate change is an unobservable consequence of gasoline usage and that people require scientific knowledge to be aware of the effects. If education levels differ geographically, then knowledge about climate change may "explain" differences in rural-urban preferences for environmental taxation. We control for this in our regressions.

[3] Some countries, such as the United States, use gasoline taxes to finance road construction projects, which suggests that gas taxes may be motivated by factors other than environmental externalities.

per capita gas consumption, in gallons, by state. On the X-axis, we indicate the share of state population living in "Urbanized Areas" (UA's) as defined by the U.S. Bureau of the Census.[4] The fitted regression line clearly indicates the negative relationship between fuel dependence and urbanization. The relationship is highly significant (t = -5.15) and substantively meaningful: a one percent increase in the share of state population living in an Urbanized Area correlates with a reduction in per capita gasoline consumption of 2.44 gallons per annum.

Just because rural citizens in the U.S. are more dependent on gasoline than urban residents does not mean they prefer lower environmental taxes due to this differential dependence. Nor does it mean that rural dwellers in other nations have preferences similar to rural U.S. citizens. To establish the wider applicability of these claims, we draw upon the World Values Survey (WVS), which conducts representative national surveys in 97 countries containing almost 90 percent of the world's population. Several waves of the WVS include a query on environmental taxation that is well suited to our purpose. Since the WVS contains additional information on respondents' backgrounds and beliefs, we are able to control for factors that might correlate with differential gasoline dependence across geographic regions (such as education and political ideology). Our findings indicate that rural dwellers are substantially less willing to use taxes for environmental purposes than urban dwellers.

[4] The Census Bureau developed the UA measure to provide a better separation of urban and rural territory. "A UA comprises one or more places ("central place") and the adjacent densely settled surrounding territory ("urban fringe") that together have a minimum of 50,000 persons. The urban fringe generally consists of contiguous territory having a density of at least 1,000 persons per square mile. The urban fringe also includes outlying territory of such density if it was connected to the core of the contiguous area by road and is within 1.5 road miles of that core, or within 5 road miles of the core but separated by water or other undevelopable territory." http://www.census.gov/geo/www/ua/uaucinfo.html

Environmental questions have been part of the WVS since the 1989-1990 wave of the survey. One query (V106) asks respondents for their views on environmental taxation; "I am now going to read out some statements about the environment. For each one read out, can you tell me whether you agree strongly, agree, disagree or strongly disagree? I would agree to an increase in taxes if the extra money were used to prevent environmental pollution." Possible answers are: 1=Strongly agree, 2=Agree, 3=Disagree 4=Strongly disagree.

The WVS contains a geographic indicator which we use to evaluate the relationship between geographic location (urban-rural) and willingness to support higher taxes for environmental purposes. The variable, "City Size," ranges from <2,000 for respondents living in communities with less than 2,000 people, to >500,000 for respondents living in cities with populations greater than half a million. **Figure 3** takes the percentage of respondents that answered "Strongly agree" and "Agree" to the environmental taxes query and arranges respondents' by city size. We restrict the sample to residents of OECD countries since we do not expect rural residents of developing countries to consume more gasoline than urban residents. A positive relationship between support for environmental taxes and city size is evident: moving from the minimum to the maximum categories of city size, there is a 7.9 percentage point increase in the share of respondents that support environmental taxes. To explore the relationship further and control for other factors that may correlate with city size, we move to regression analysis.

There are several factors omitted from **Figure 3** that may vary along urban-rural geographic lines and therefore be the underlying "cause" of the relationship. For example, if city dwellers are more educated on average than rural citizens about the need for governments to tax activities that produce environmental externalities, then we might be mistaking differential environmental education for deferential dependence on fuel consumption across the rural-urban divide. Similarly, if cities tend to be more polluted than rural areas, urban dwellers might have greater awareness of environmental problems and therefore be more willing to support environmental taxation than rural residents. Finally, political ideology could plausibly vary geographically, with urbanites more "liberal" and supportive of government intervention to protect the environment than rural residents.

In **Table 1**, we control for these potential omitted variables. The table reports results of ordered probit regressions where the dependent variable is the individual response to the WVS query, "I would agree to an increase in taxes if the extra money were used to prevent environmental pollution." For easier interpretation, we recoded responses so that higher values indicate greater support for environmental taxation (1=Strongly disagree, 2=Disagree, 3=Agree 4=Strongly agree). Additionally, we weight the data to reflect some of the differences between the responding sample and actual population characteristics as reported by the WVS. The WVS documents a number of oversampled groups, some oversampled purposely and others through response rates, so this should help account for some of the sampling bias. Model 1 includes only our variable of interest, "City Size", which ranges from 1 for respondents living in communities with less than 2,000 people, to 9 for respondents in cities with populations of more than 500,000. Model 2 adds controls from the WVS for knowledge about environmental policy, local environmental conditions, and political ideology. We use "Education Attainment" as a proxy for knowledge about the role of government taxes and environmental externalities. The variable ranges from 1=No formal education to 9=University with degree. The WVS also asks respondents how serious certain environmental problems are in the communities in which they live. We use the response to a query about local air pollution (v109) to control for urban-rural differences in perceived environmental conditions. We recoded responses to range from 1= Not serious at all, to 4=Very serious. To control for the possible overlap between political ideology and urban-rural location, we use "Ideology," which is a respondent's self-identified position on a left-right political scale, where 1=Far left and 10=Far right.[5] Finally, in Model 3 we control for respondents' concern for the global warming problem, which may also vary by urban-rural location. The WVS asks respondents (V111) to state how serious they think global warming or the greenhouse effect is for the world as a whole. We recoded responses to range from 1= Not serious at all, to 4=Very serious.

Table 1 reports our results. In every model, our variable of interest, "City Size," is positive and highly significant. The population of a respondent's town or city remains positive and significant when we control for the respondent's educational attainment, political ideology, concern about global warming, and air pollution levels in the respondent's community—all of which may vary along the urban-rural divide. Note that the signs of all controls are intuitive: respondents with more education are more likely to support environmental taxes, as are people that live in communities with more air pollution and people that express more concern about global warming. Likewise, the negative sign on "Ideology" indicates that conservatives tend to oppose environmental taxes.

Since the substantive meaning of these ordered probit estimates is not directly interpretable, we simulated the change in predicted probabilities caused by moving "City Size" from low to high values using the "Clarify" software (Tomz, Wittenberg, and King, 2003). The effect is small but meaningful and highly significant. Moving "City Size" from the 25th percentile (5,000-10,000 population) to the 75th percentile (100,000-500,000 population)

[5] The query (V114) is, "In political matters, people talk of "the left" and "the right." How would you place your views on this scale, generally speaking?"

increases the probability of obtaining a “Strongly agree” or “Agree” response to the environmental taxes query by just under two percentage points, holding other variables in Model 3 at their means. With the confidence interval ranging from 0.001 to 0.034, this estimate is significant at the 95 percent level.

In this section, we have shown that: (1) gasoline dependence is higher in rural areas than in urban areas in the United States, and that (2) rural inhabitants express less support for environmental taxation than urban residents across the OCED. In our regressions, we controlled for a number of non-pecuniary factors that may correlate with respondents’ geographic (urban-rural) location—education, ideology, exposure to pollution—and found that the distributional effects of environmental taxation still matter: residents of smaller (rural) communities are more likely to oppose environmental taxes than urban voters.

3. Malapportionment and Gasoline Taxes

In higher income countries, residents of rural communities are more dependent on gasoline consumption than urban residents; they also express less support for using taxes to deal with environmental externalities. Both facts suggest that rural voters will oppose high gasoline taxes. But will this opposition affect gasoline tax *policy*? In this section, we argue that it will, especially where malapportionment magnifies the political influence of rural districts. Otherwise, urban residents, who outnumber rural citizens in the electorate, would obtain their preferred policy.

A malapportioned political system is one in which the votes of some citizens count more than the votes of others, due to a discrepancy between the share of the population held by electoral districts and the share of legislative seats. Put another way, malapportionment occurs “when geographical units have shares of legislative seats that are not equal to their share of population" (Monroe 1994). In the extreme hypothetical case, one voter in one (tiny) district would be given electoral control over all the seats in the legislature while the rest of the voters would control no seats. According to Samuels and Snyder (2001, p. 654), some degree of malapportionment is a characteristic of almost all political systems, and deviations from the "one person-one vote" principal are very large in some countries. The United States, for example, has one of the most malapportioned systems in the world, due to the Senate, where political power is apportioned equally among the states, regardless of their population. This means that the state with the smallest population (Wyoming) has 2 senators per million voters, while the most populous state (California) has but 0.06 senators per million voters. Overall, the 21 smallest states have the population of California but 42 Senators compared to California's two.

Many nations have malapportioned systems and severe malapportionment is usually a feature of upper chambers. Samuels and Snyder (2001) measure the level of malapportionment in 78 countries and find that the worst cases--Argentina, Brazil, Bolivia, the Dominican Republic, the United States, Switzerland, Russian Federation, Venezuela, Chile, Australia, Spain, Germany, Mexico, South Africa, and Poland—all have extremely malapportioned upper chambers. Yet Samuels and Snyder also find high levels of malapportionment in many lower chambers, challenging the notion that malapportionment is strictly associated with bicameralism (Lijphart 1994; Tsebelis and Money 1997).

Many studies find malapportionment to have policy consequences.[6] Furthermore, a substantial literature identifies malapportionment as a source of a *rural bias* in public policies. For example, Thies (1998) shows that malapportionment in Japan and the United States perpetuates agricultural subsidy programs that transfer income from urban consumers to rural

[6] For an introduction to this literature, see the references in Samuels and Snyder (2001, fn7).

producers even in the face of massive shifts of populations toward the cities. Snyder and Samuels (2001) examine malapportionment in 19 Latin American countries and find that malapportionment produces a systematic overrepresentation of rural interests in both lower and upper chambers. This is consistent with Lijphart (1994), who notes "Malapportionment often takes the form of rural or regional overrepresentation."[7] Yet, to our knowledge, no one has examined the effects of malapportionment on environmental taxation. The nearest related literature borrows from Persson and Tabellini (2000) to argue that nations with proportional representation (PR) have stricter environmental policies than nations with majoritarian electoral systems (Fredriksson and Millimet 2004).[8] Beyond this work here, there is little political economy research on cross-national differences in environmental taxation.

Our main dependent variable in this section is the total tax on gasoline, which proxies for environmental taxes more generally (Fredriksson and Millimet 2007). Our gasoline tax data are from the International Energy Agency's (IEA) *Energy Prices and Taxes* series and includes all taxes—sales, excise, VAT, etc—paid by the final end-use gasoline consumer. The total gas tax is measured in current U.S. dollars per liter. We use the IEA series on the total tax (US$/liter) for Premium Unleaded 95 RON gasoline, as it provides the widest country coverage. When the tax on Premium Unleaded 95 RON gasoline is unavailable, we substitute the tax on Premium Unleaded 98 RON or the tax on Regular Unleaded Gasoline.

Our variable of interest is "Malapportionment," which we expect to have a negative influence on gasoline taxes. Our data on malapportionment is from Samuels and Snyder (2001).

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[7] See also Jackman (1994), Horiuchi (2004), Grace (2006), Lee (1998), Cho (1976), and David and Eisenberg (1961).

[8] See also Fredriksson and Millimet (2007) for a "veto players" approach to the topic.

To measure malapportionment, Samuels and Snyder construct an index, MAL, which is given by:

$$MAL_j = \frac{1}{2}\sum_{i=1}^{N} | s_i - v_i |$$

where Σ is the summation over all districts *i*, s_i is the percentage of all seats allocated to district *i*, and v_i is the percentage of the overall population (or registered voters) residing in district *i*. To give an intuition of its range, where MAL=0, no citizen's vote weighs more than another's. Where MAL=0.3, thirty percent of seats are allocated to districts that would not receive these seats if there were no malapportionment. MAL=1 is the extreme case, where all seats are allocated to one district with only one voter.

Samuels and Snyder (2001) provide separate measures of malapportionment for lower and upper chambers in 78 countries.[9] As we are interested in the overall level of malapportionment in a political system, we average the values for the lower and upper chambers, but only if the upper chamber is effective and has influence over public policy. To determine whether the upper chamber is "effective," we draw upon Tsebelis and Money (1997), who code upper chambers according to whether they have effective legislative power on financial (fiscal) legislation. If there is no upper chamber, or if the upper chamber is ineffectual on fiscal policy, we use the lower chamber value of malapportionment.

The scatter plot in **Figure 5** provides an initial look at the relationship between malapportionment and gasoline taxes for the 30 countries for which we have data.[10] Countries

[9] We added eight more cases to the dataset, using the same formula: Botswana, Bulgaria, Guyana, Indonesia, Luxembourg, Moldova, the Philippines, and Singapore.

[10] Gasoline tax data for this cross section are from 1995, the modal year for Samuels and Snyder's measurement of malapportionment.

with greater levels of malapportionment tend to have lower taxes on gasoline. Since differences in taxes explain most of the difference in gas prices internationally (see **Figure 1**), we expect the same relationship to be evident in the gasoline *price* data, for which we have greater coverage.[11] **Figure 6** plots 67 countries by their gas prices and levels of malapportionment and, although this sample includes many low-income countries, a negative relationship is still evident.

To control for factors that may correlate with malapportionment, we move to regression analysis. Model 1 in **Table 2** provides a baseline estimate, with no controls. Model 2 controls for the level of development (with GDP per capita in US$1,000s) since citizens in richer countries might prefer higher environmental taxes. Model 3 includes a control for CO^2 emissions, measured in metric tons per capita. We control for CO^2 emissions since gasoline taxes might differ nationally, due to variation in dependence on fossil fuels. Model 4 controls for the overall level of taxation, with a variable that measures the taxes on income, profits and capital gains as a percentage of GDP. We control for this because lower overall taxes might correlate with malapportionment for some reason. Finally, in Model 5 we include a dummy variable equal to 1 for countries with proportional representation electoral systems.[12] According to Fredriksson and Millimet (2004), PR systems tend to produce higher environmental taxes than majoritarian systems. For all data in these models, see **Appendix A**.

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[11] End-use gasoline "pump" price data are also from the IEA. As with the gas tax data, we take values for Premium Unleaded 95 RON gasoline but substitute the price of Premium Unleaded 98 RON or the price on Regular Unleaded Gasoline when necessary to expand coverage.

[12] Data on income per capita and CO^2 emissions are from the World Bank's *World Development Indicators*. Taxes on income, profits and capital gains are from the OECD (2008) *Revenue Statistics, 1965*-2007 (category 1000, which includes taxes on individuals and corporations). The PR dummy is from the World Bank's *Database on Political Institutions.* All values for these variables are for year 1995.

In **Table 2**, our variable of interest—Malapportionment—remains negative and significant in all models. In Model 1, malapportionment alone accounts for 25 percent of the cross-national variation in gasoline taxes. When we control for GDP per capita in Model 2, the fit improves to 54 percent. Adding the control for CO^2 emissions per capita improves fit further and does not weaken the relationship between malapportionment and gasoline taxes. With all other variables held at their means, a shift from the mean to no malapportionment—a country like Israel or the Netherlands—corresponds to an increase in the gas tax of roughly $0.13 from $0.57 to $0.70. An increase from the mean level of malapportionment to one standard deviation above—close to that of Mexico—corresponds to a $0.11 decrease in gas taxes, from $0.57 to $0.46. While the level of development (GDP per capita) and fossil fuel dependence (CO^2 emissions) have large and statistically significant effects, in Model 4, our control for the overall tax level (Taxes on Income, Profits, and Capital Gains as a percentage of GDP) does not. Similarly, in Model 5, the control for proportional representation electoral systems has a positive yet insignificant effect.

In **Table 3** we report results using end-use gasoline prices (pump prices) as the dependent variable, instead of gas taxes. As discussed above, nearly all of the variation in gasoline prices is due to differences in gasoline taxes. By using end-use gasoline price, we expand our coverage to 67 countries. In the baseline model (Model 1), malapportionment is negative and highly significant even though the sample includes many developing countries (see **Appendix A** for the country list). We do not expect the rural sector in poor countries to be more dependent on fossil fuels than the urban sector, which may explain why the coefficient estimate is smaller in the baseline gas price model than in the baseline gas tax model. In Models 2 and 3, we control for GDP per capita and CO2 emissions per capita respectively and results are consistent with the gas tax results. In Model 4, we introduce the control for the general level of taxation (Taxes on Income, Profits, and Capital Gains), which is available only for OECD countries. This developed country context is where we expect our argument about rural bias to be most relevant since rural residents depend more heavily on fossil fuels than urbanites in developed countries. The results in Model 4 support this assumption: when the sample is limited to OECD countries, the coefficient estimate on Malapportionment more than doubles in value from when the sample includes developing countries (Models 2 and 3). When we estimate the substantive effect of a change in malapportionment in Model 4, we find that a move from the mean to zero malapportionment leads to an increase in the pump price of $0.16, from $0.89 to $1.05 per liter. An increase above the mean of one standard deviation leads to a decrease in the pump price to $0.76. Lastly, Model 5 controls for the type of electoral system (proportional representation) but again the effect is small and insignificant.

4. Malapportionment and Support for the Kyoto Protocol

We have shown that individuals prefer lower gasoline taxes when they come from a more rural setting, and that these preferences affect policy when malapportioned political institutions magnify them. In this section, we hypothesize that the same determinants of gasoline taxes across countries should be able to predict other environmental policies.[13] If limiting the emission of greenhouse gases were generally more costly for rural citizens, then we would expect rural dwellers to be less supportive of international agreements, like the United Nations Kyoto Protocol, that bind governments to these reductions. As such, we predict that

[13] Fredriksson and Millimet (2007) argue that gasoline taxes are a reasonable proxy for the overall environmental policies of a country.

malapportionment—which generally overrepresents the interests of the rural populace—should overrepresent interests that oppose the international environmental agreement.

Environmental problems at the scale of global climate change and the limiting of greenhouse gases (GHGs) requires an international approach (Beron et al. 2003). However, international environmental agreements, like many international arrangements, have distributional consequences within countries as well as across them. When these agreements require representative legislatures to debate and approve the regulations, the composition of those legislatures and the interests they represent are paramount to the outcome. Our argument about the effects of malapportionment should thus play an equivalent role in the approval of environmental agreements. As with gasoline taxes, our premise is that rural interests have more to lose from agreements that require limits on GHG emissions.

Residents of cities should be more willing to support international environmental agreements if the burden of GHG reduction falls more directly on rural citizens. According to Dodman (2009), cities are not to blame for global warming. In high-income countries, residents of major cities generally push heavy polluters outside their borders while urban density helps create the environmental efficiencies that make cities less harmful overall. As a result, suburbs and rural areas produce a larger share of the pollution. However, as argued in previous sections, the very density that creates these environmental efficiencies may harm urban dwellers' political voice if malapportionment exists. To evaluate the argument, we test to see if countries with higher levels of malapportionment took longer to ratify the Kyoto Protocol to the UN Framework Convention on Climate Change than countries with equitable representation of urban constituents.

Ratification of the Kyoto Protocol provides a theoretically compelling case on which to test this argument. The treaty requires Annex 1 ratifying states to reduce GHG emissions by specified amounts on a fixed timeline.[14] While the head of state may sign the treaty, ratification requires legislative approval in most of the Annex 1 countries. As cross-national bargaining influenced the size of the cuts to which these states agreed, we assume that negotiators had information about the preferences of their home country. Ratification is then dependent on the legislative institutions.

A number of other studies have tackled the issue of Kyoto Protocol ratification. Von Stein (2008) argues that the creators of environmental agreements have to make tough decisions when choosing different elements of the agreement. Mechanisms that deter defection might also deter participation. She finds that legalized mechanisms and higher compliance standards hamper ratification of the Kyoto Protocol. In addition to the legalization literature, she integrates network variables looking at how connected a state is in the international system by way of memberships in international organizations. However, these variables do not perform well in her statistical analysis.

Arguments derived from sociology's ecological modernization theory (EMT) assert that modernization, the phenomena that many fault for the degradation of the environment, is important for increasing environmentally friendly policy (Zarhan et al. 2007). Generally, economic modernization is associated with increased efficiency and lower emissions. However, they also stress non-economic factors. First, these modernized economies require better governance, and better governance helps to create balance between the environment and

[14] Annex 1 countries are those that were members of the OECD at the time of the signing of the United Nations Framework Convention on Climate Change in 1992. Additionally a number of "economies in transition" from Central and Eastern Europe are included in the Annex 1 group.

economy. Second, a cultural shift associated with post-material values provides a public who—now having relative economic security—are willing to support an environmental agenda. They argue that measuring the determinants of EMT will provide a better prediction of a country's willingness to join an international environmental agreement. However, their empirical results are mixed.

Fredriksson et al. (2007) focus specifically on the effect of lobbying on Kyoto ratification. Their theory argues that increases in the size of the environmental lobby should increase the probability that a country ratifies Kyoto. Additionally, corruption creates another venue through which the environmental lobby can influence politicians. Thus as corruption increases, the effectiveness of the environmental lobby should increase as well. They find support for both their claims.

What these studies lack, in our opinion, is a consideration of the political institutions that connect the preferences of citizens and lobby groups to the policy outcomes. While Fredriksson et al. (2007) and Zarhan et al. (2007) include measures of domestic interests in their models, they do not have a measure of how those interests are aggregated. This omission is important because the method by which domestic interests aggregate shapes a country's overall support for joining the international agreement. The same holds for Von Stein (2008) analysis, since the degree to which an international agreement finds support domestically is at least partly a function of the biases inherent in domestic ratification procedures. Additionally, recent work on bilateral investment treaties finds legislative hurdles increase the time until ratification (Haftel and Thompson 2009). We build on these works by providing a theory that integrates interests and institutions to predict the duration between treaty signing and ratification.

To test our argument about the malapportionment bias, we use a replication dataset from Von Stein (2008).[15] We limit our sample to Annex 1 (industrialized) countries since these countries agreed to mandatory reductions in GHGs on a fixed timetable. Our variable of interest is "Malapportionment," measured as before (see the discussion in Section 3).[16] We expect the coefficient on this variable to be negative, as states with greater malapportionment should be less likely to ratify and less likely to succumb to other pro-treaty lobbying pressures. Put another way, greater malapportionment increases the spell of non-ratification.

Following the approach in Von Stein (2008) and other studies, we use survival analysis to assess our claims. Survival analysis allows us to estimate a country's "spell" (in months) to ratification. In addition to our main explanatory variable, we include a number of other control variables often cited as alternative explanations for ratification. Both the literature on the Environmental Kuznets Curve and the arguments from Zarhan et al. (2007) make the case that economic development may predict a country's commitment to higher environmental standards. Countries vary in their level of development and less developed countries are more aware of the costs of limiting their growth by increasing the cost of manufacturing associated with GHGs. To control for this possibility, we include a measure of per capita GDP. We expect this variable to have a positive coefficient, as richer countries will be more likely to ratify earlier. However, we expect a muted effect in the restricted sample. Additionally, Neumayer (2002) finds that democracies are more likely to make environmental commitments than non-democracies. While

[15] The results found here are robust to similar models produced with replication data from Neumayer (2007) and Zarhan et al. (2007).

[16] One possible weakness is that our malapportionment data do not reflect any redistricting or reapportionment changes that may have occurred between the time it is measured (by Samuels and Snyder in the mid- to late-1990s) and the ratification timeframe of the Kyoto Protocol. However, a test on a small, random sample found no evidence of such changes.

our theory applies only to countries with democratic institutions, we expect that democracy, measured by way of the Polity2 index, will remain positive in our models, albeit possibly without significance given the low variation in democracy among Annex 1 countries.

Stone and Plaxina (2005) argue that side payments, especially from the European Union, are important in enticing nations to ratify Kyoto. We do not have measures of bilateral aid, but we include an indicator of whether or not that state was a candidate for EU membership as a control. We include other variables that may have an impact on ratification in some specifications (for discussion of these variables, see Von Stein 2008).

Table 4 presents the results of our analysis, which support our hypothesis. In Model 1, we begin with a baseline model including our measure of malapportionment. Higher levels of malapportionment tend to decrease the probability that a country ratifies Kyoto; put another way, greater malapportionment increases the spell of non-ratification. In Model 2, we add a number of controls and malapportionment remains negative and statistically significant. The other variables generally perform as expected. The larger a country's target reduction in GHGs, the longer the spell between introduction of Kyoto and ratification. Wealthier countries are associated with ratifying Kyoto sooner. Additionally, Polity2 has a positive coefficient, but is statistically significant only at the ten percent level. Consistent with Stone and Plaxina (2005) the candidates for EU membership are more likely to sign earlier. Including a year counter does not affect the results for malapportionment. In model 3 we include other variables that represent some domestic interests and some of the costs associated with Kyoto compliance. Most important for our theory, malapportionment remains significant and robust to these additions. Both a country's deviation from their target cut and the GDP per capita variable perform as before. Polity2, however, loses significance but keeps a positive coefficient. This is likely due to the restricted developed country sample. While Greenpeace membership is positive as in Von Stein (2008), it is not statistically significant. Additionally, gasoline and coal exports are not significant but they do have the expected negative sign. Industry as a percentage of GDP has a statistically significant positive coefficient, contrary to what we might predict. In all models, we are able to reject the null hypothesis that the hazard function is constant. These results are robust to analysis only on the OECD subset of Annex 1 countries. Furthermore, our results are not sensitive to the Weibull distribution, as they are consistent in the Cox proportional hazard model.

Figure 7 below plots the survival function of Model 3 in **Table 4**. By varying malapportionment by on standard deviation above and below the mean level, the plot helps illustrate how higher levels of malapportionment create a significant lag in the time between the establishment of the convention and domestic ratification. Because our measure of malapportionment does not vary over time, the lines show shifts, rather than changes in the slope.

5. Conclusion

Given our analysis, we find it no surprise that the rural sector in the United States has mobilized to oppose climate change legislation. Arguing that congressional climate change legislation will impose a massive new gasoline tax on farmers and ranchers, the American Farm Bureau (AFB) recently initiated a "Don't CAP Our Future" campaign to derail the legislation (Galbraith 2009). The campaign's organizers at the AFB have encouraged members to place a "Don't CAP Our Future" sticker on a farmer's cap and hand-deliver it to a local office of the United States Senate. Senators from rural states appear to be responsive. On October 21, 2009, Kay Bailey Hutchison (R-TX) and Christopher "Kit" Bond (R-MO) released a Senate report entitled "Climate Change Legislation: A $3.6 Trillion Gas Tax." According to the report, U.S. farmers and ranchers will incur higher fuel costs of $550 million in 2020, rising to $1.65 billion by 2050.[17] Speaking at the Capitol Hill news conference that accompanied the release of the Hutchison-Bond report, Texas farmer and livestock producer Richard Cortese expressed the rural sector's concerns: "Agriculture is an energy-intensive business. I use diesel fuel for tillage, planting, harvesting and spraying. And I use gasoline for service vehicles for checking livestock, utility vehicles and small engines. Having a reliable and affordable supply of gasoline and diesel fuel is very important for my operation to continue to make a living for me and my family."[18] Cortese then explained how increasing fuel costs under cap-and-trade legislation raised enormous concerns for farmers and ranchers.

This line of reasoning resonates with the argument of this paper. Net rural incomes would indeed fall disproportionately with the passage of climate change legislation that raises fuel costs since fuel and energy-related inputs account for a significant portion of farm and ranch operating expenses. We show that rural citizens depend more on fuel than urban residents and that rural residents express less support for using taxes to deal with environmental externalities. This evidence supports our premise that the distributional aspects of environmental taxation vary geographically, across urban-rural lines. Yet since rural residents are in the minority in developed countries, we do not expect the rural preference for low environmental taxes to have a powerful effect on policy *unless* the political system is biased. Our core argument is that malapportionment creates such a bias and thereby skews environmental policy toward the interests of rural residents.

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[17] The report is available at
http://hutchison.senate.gov/resources/HutchisonBondGasTaxReport.pdf

[18] Cited in a news release from the American Farm Bureau:
http://www.fb.org/index.php?fuseaction=newsroom.newsfocus&year=2009&file=nr1021.html

To evaluate this claim, we regressed variables that proxy for "environmental policy" on malapportionment. Findings from these analyses support our argument. First, nations with malapportioned political systems have lower gasoline taxes—and lower pump prices—than nations with more equitable representation of (urban) constituencies. Second, countries with higher levels of malapportionment took longer to ratify the Kyoto Protocol to the UN Framework Convention on Climate Change than countries with equitable representation of urban constituents.

These results are important because they show that political institutions—specifically, malapportioned legislatures—can shape environmental policy outcomes. Malapportionment may be steering some of the largest economies and markets away from more environmentally friendly laws and delaying agreement on global efforts to combat climate change. In many of these cases, this institutional variation is the result of antiquated and idiosyncratic historical choices. But the evidence points to an unintended consequence in the realm of environmental policy. Moreover, our results also help to account for some obvious paradoxes. For example, why do the United States and the United Kingdom lie at opposite ends of the spectrum in terms of gasoline taxes? For countries that share so many cultural, economic, and social characteristics, this is something of a puzzle. In the United States, but not in England, the voters that are most harmed by high environmental taxes—rural voters—are are systematically overrepresented in the political system. To be sure, much of the debate in Copenhagen will dwell on the exceptions of certain industries, the requirements on different countries, or the exact benchmarks states must achieve. However, this paper illustrate why for all the efforts to produce successful action on climate change today, constitutional compromises over political institutions, in some cases over 200 year old, may be important factors in determining successful cooperation.

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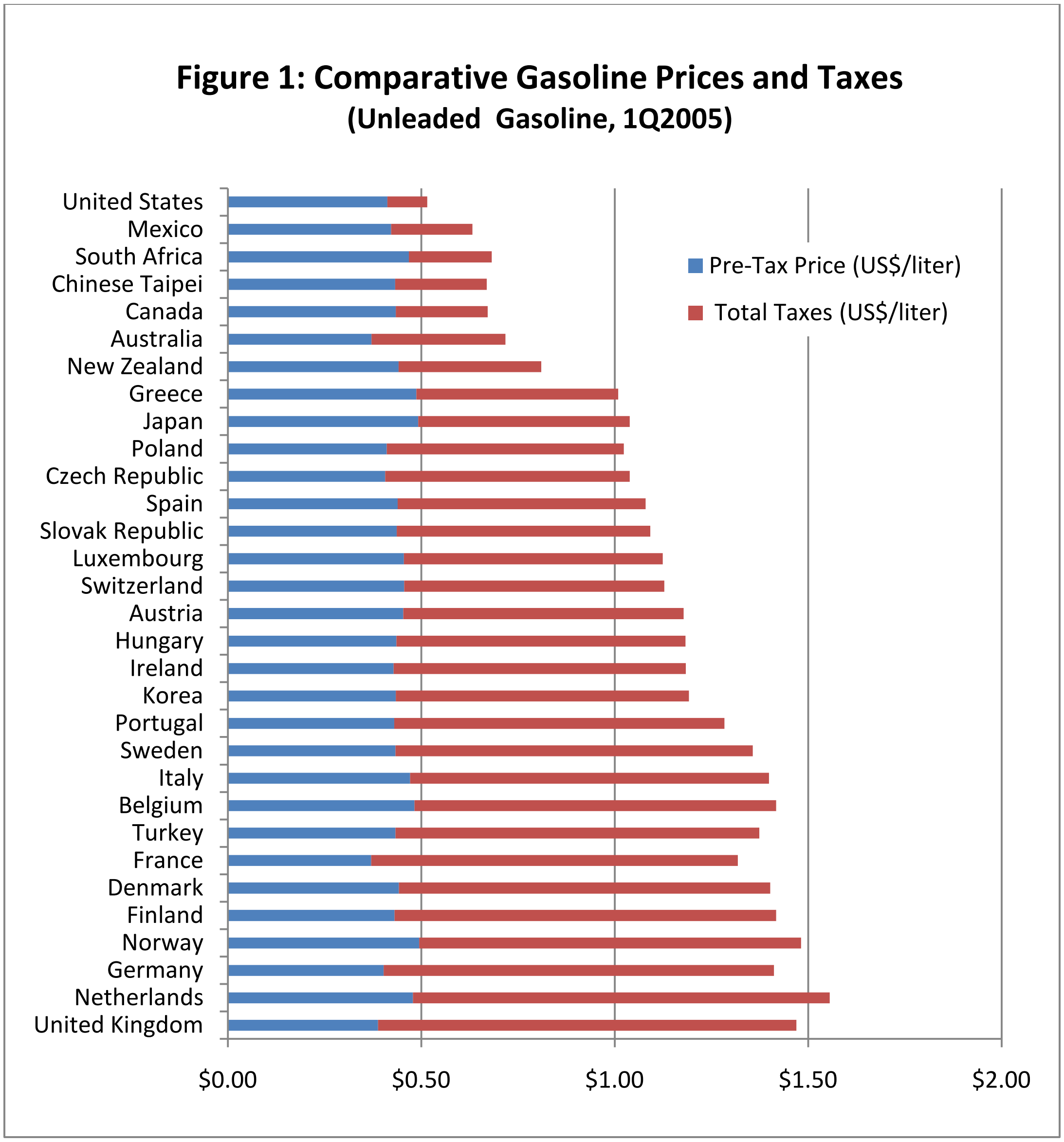


Notes: "Total Taxes" include all taxes which have to be paid by the consumer as part of the transaction and which are not refundable (sales tax, excise tax, VAT, etc). Gas tax and price data are from the International Energy Agency, *Energy Prices and Taxes: Quarterly Statistics*, 2005.

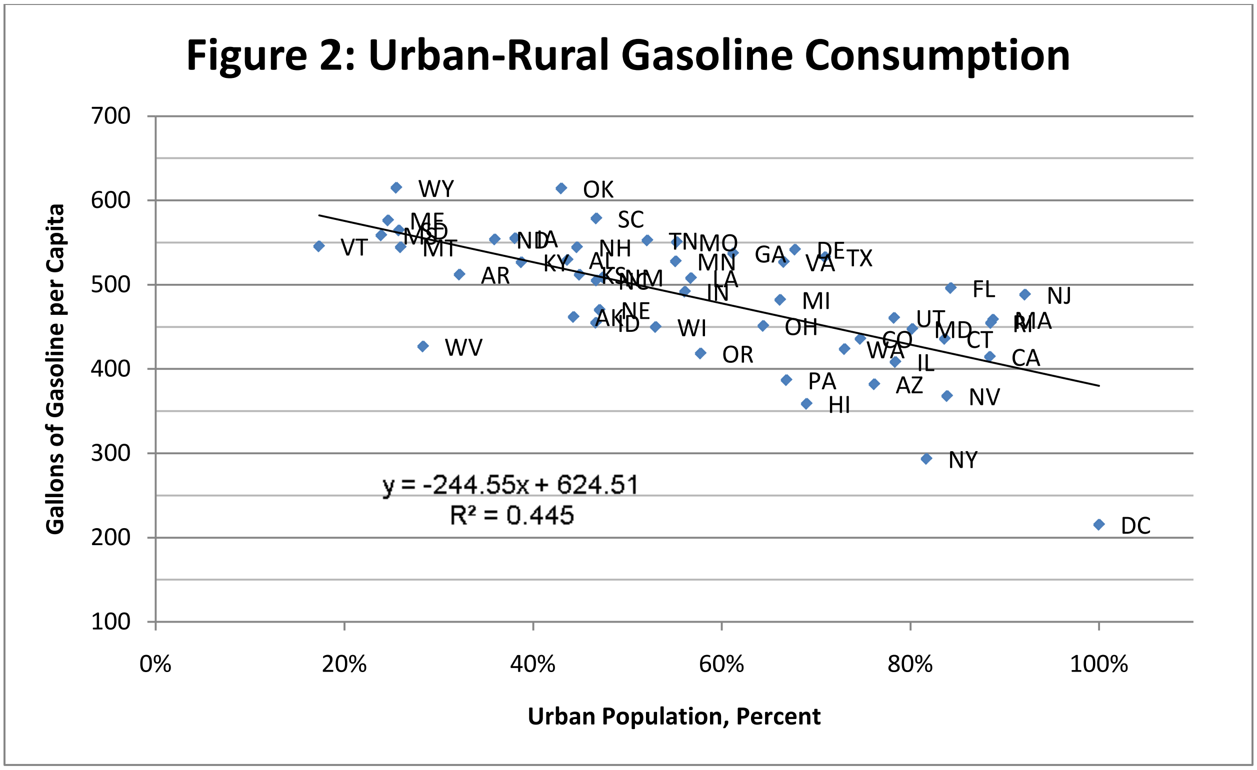
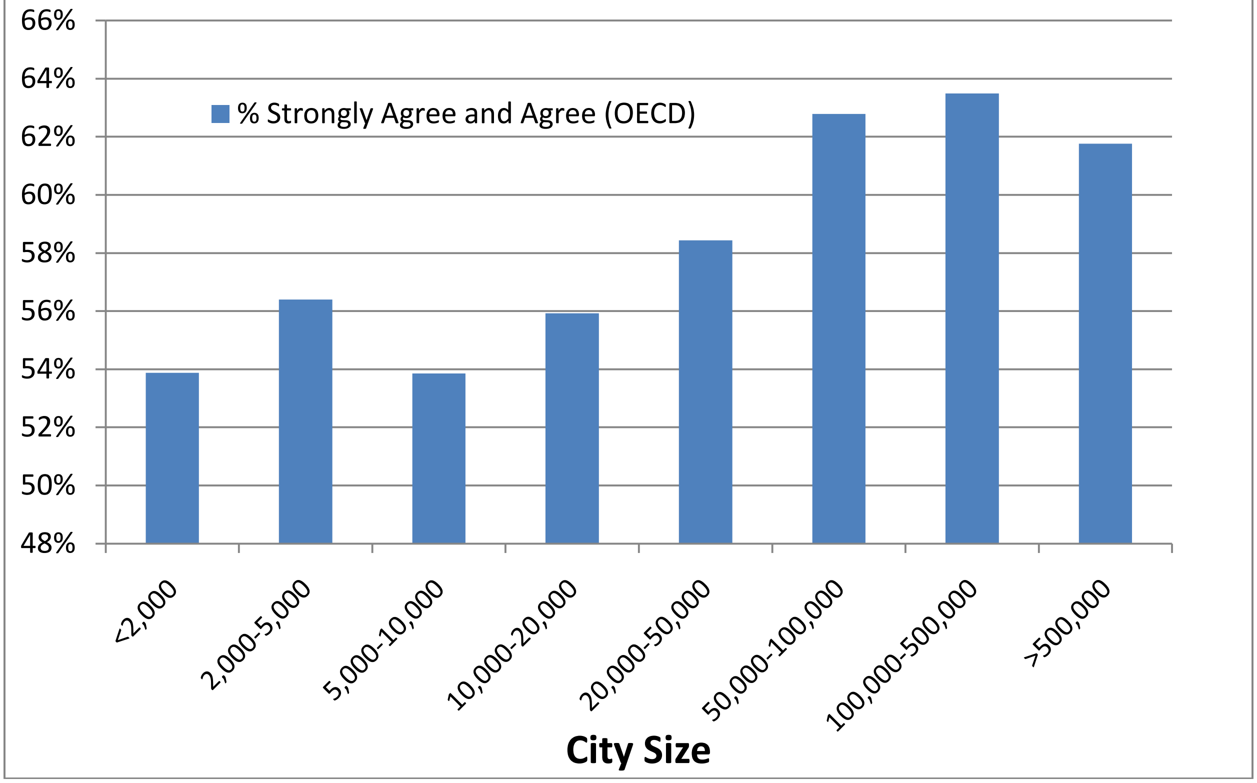


Figure 2: Urban-Rural Gasoline Consumption

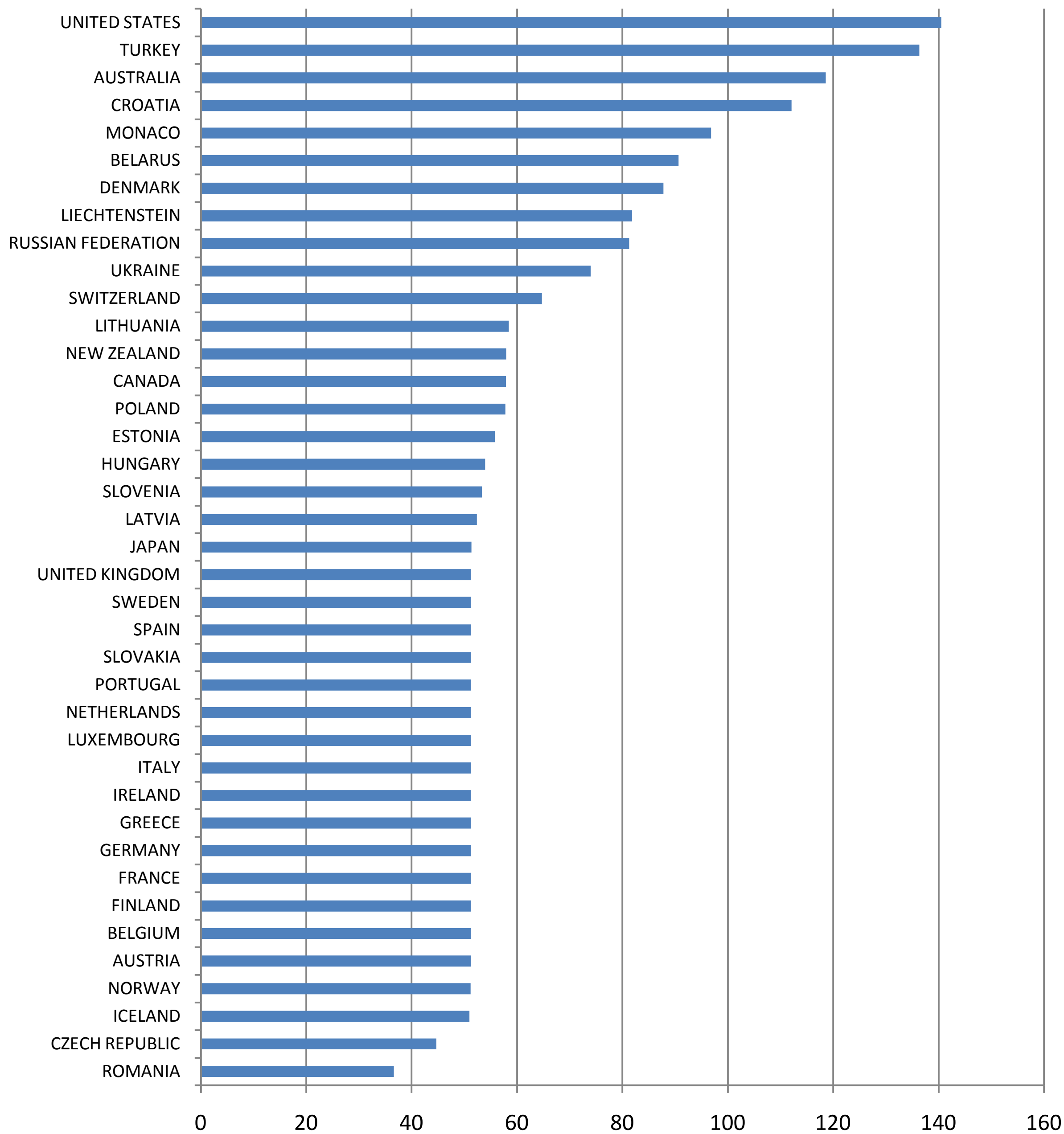
Notes: Data on per capita gas consumption by state is from the California Energy Commission, based on U.S. Department of Energy and U.S. Bureau of the Census data. Urban Population is the share of state population living in "Urbanized Areas" (UA) as defined by the U.S. Bureau of the Census (a UA is a densely settled area of at least 50,000 people).

Figure 3: Agree to an Increase in Taxes if Used to Prevent Environmental Pollution?



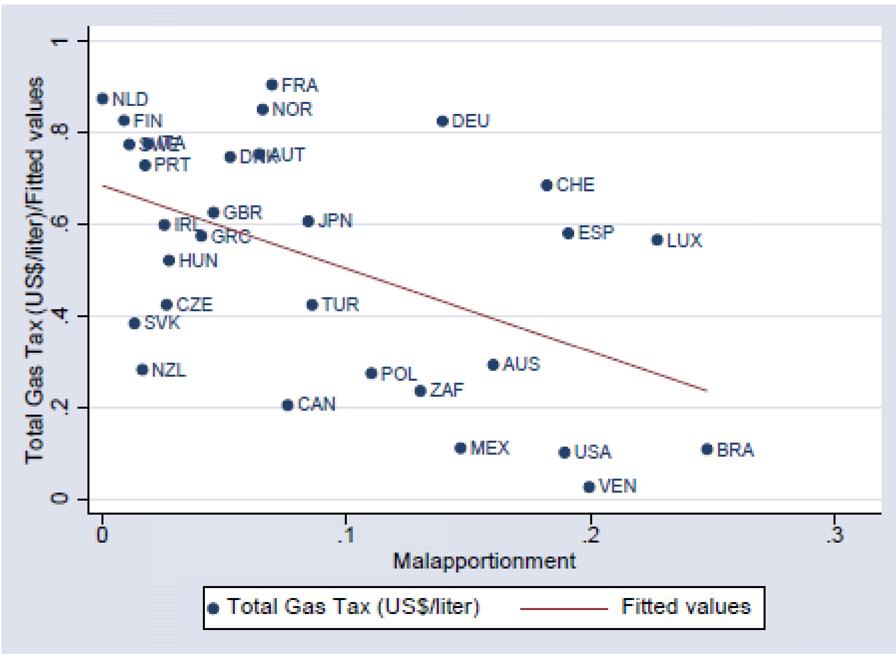
Notes: The bars indicate the percentage of all respondents that answer "Strongly agree" and "Agree" to the World Value Survey query: "I would agree to an increase in taxes if the extra money were used to prevent environmental pollution."

Figure 4: Duration until Kyoto Ratification (months)



Notes: Bars represent the time, in months, between the creation of the Kyoto Protocol to the United Nations Framework Convention on Climate Change and domestic ratification. Data for EU members calculated based on the joint deposit of the then 15 members at the UN. The U.S. has yet to ratify. For illustration purposes, the US data is set as 9/30/2009. Data are from UNFCCC's *Kyoto Protocol Status of Ratification*, available at: http://unfccc.int/files/kyoto_protocol/status_of_ratification/application/pdf/kp_ratification_20090826corr.pdf.

Figure 5: Malapportionment and Gasoline Taxes



Notes: Gasoline tax data are for year 1995—which is the modal year of the malapportionment data from Samuels and Snyder (2001)—and are from International Energy Agency, *Energy Prices and Taxes: Quarterly Statistics*, 2005.

Figure 6: Malapportionment and Gasoline Prices

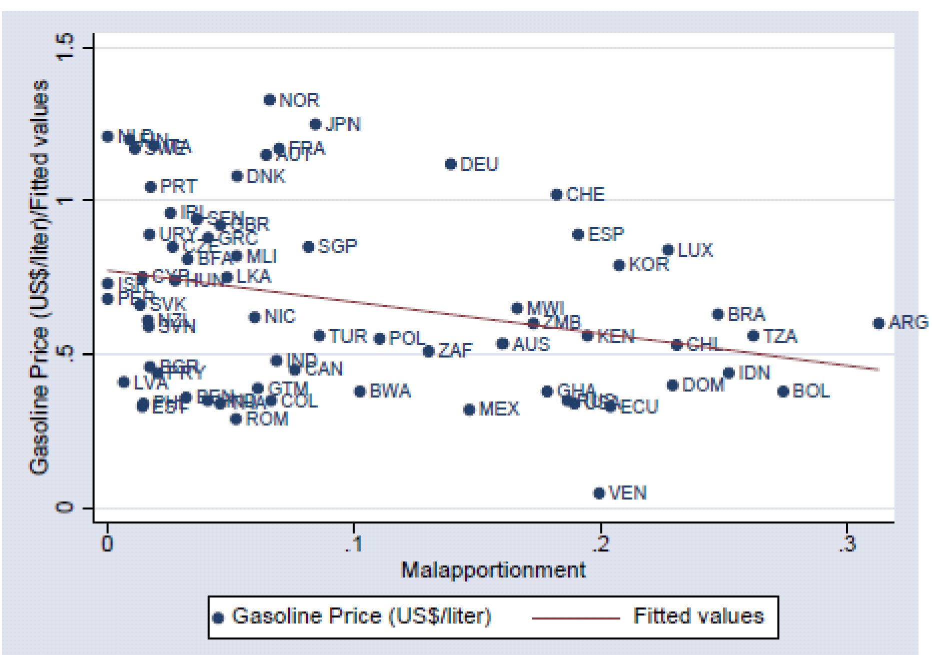


Figure 7: Survival Function Plotted with Varying Levels of Malapportionment

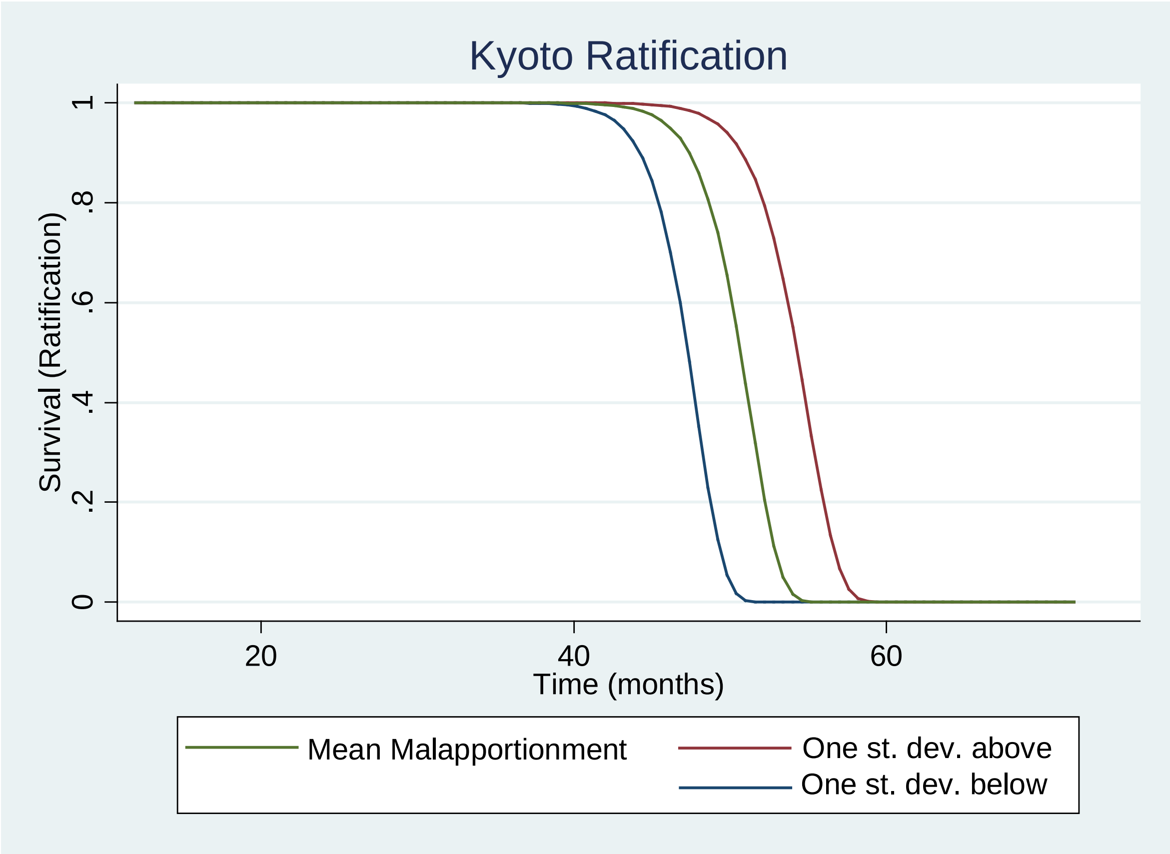


Table 1: City Size and Individual Support for Environment Taxes

Support for Environment Taxes	(1)	(2)	(3)
City Size	0.033	0.012	0.011
	(0.003)***	(0.005)**	(0.005)**
Education Attainment		0.092	0.085
		(0.006)***	(0.006)***
Ideology		-0.038	-0.031
		(0.006)***	(0.006)***
Local Air Pollution		0.057	0.036
		(0.011)***	(0.011)***
Concern for Global Warming			0.252
			(0.018)***
Observations	35,667	10,198	10,079
Pseudo R^2	0.002	0.0216	0.0307

Robust standard errors in parentheses. * significant at 10%; ** at 5%; *** at 1%

Notes: Ordered probit regressions where the dependent variable is the individual response to the WVS query, “I would agree to an increase in taxes if the extra money were used to prevent environmental pollution.” (1=Strongly disagree, 2=Disagree, 3=Agree 4=Strongly agree).

Table 2: Malapportionment and Gasoline Taxes in 30 Countries

	(1)	(2)	(3)	(4)	(5)
Malapportionment	-1.809	-1.97	-1.771	-1.619	-1.623
	(0.592)***	(0.448)***	(0.410)***	(0.676)**	(0.726)**
GDP per capita (1,000s)		0.013	0.018	0.018	0.018
		(0.003)***	(0.003)***	(0.005)***	(0.005)***
CO^2 Emissions per capita			-0.022	-0.022	-0.027
			(0.008)**	(0.010)**	(0.013)*
Taxes on Income, Profits,				-0.006	0.0004
Capital Gains (% of GDP)				(0.009)	(0.023)
Proportional Representation					0.03
					(0.074)
Constant	0.683	0.479	0.582	0.664	0.592
	(0.059)***	(0.060)***	(0.079)***	(0.094)***	(0.118)***
Observations	30	30	30	26	18
R-squared	0.25	0.54	0.64	0.54	0.67

Robust standard errors in parentheses. * Significant at 10%; ** at 5%; *** at 1%

Note: OLS regressions where the dependent variable is the total tax on gasoline paid by the consumer (US$/liter).

Table 3: Malapportionment and End-Use Gasoline Prices in 67 Countries

	(1)	(2)	(3)	(4)	(5)
Malapportionment	-1.029	-0.92	-0.93	-1.927	-1.713
	(0.345)***	(0.303)***	(0.264)***	(0.717)**	(0.784)**
GDP per capita (US$ 1,000s)		0.019	0.028	0.023	0.021
		(0.003)***	(0.003)***	(0.004)***	(0.006)***
CO^2 Emissions per capita			-0.027	-0.027	-0.03
			(0.008)***	(0.013)**	(0.016)*
Taxes on Income, Profits,				-0.008	-0.002
Capital Gains (% of GDP)				(0.008)	(0.027)
Proportional Representation					0.018
					(0.096)
Constant	0.773	0.592	0.659	0.989	0.933
	(0.054)***	(0.050)***	(0.053)***	(0.110)***	(0.153)***
Observations	67	67	67	27	19
R-squared	0.09	0.5	0.59	0.62	0.59

Robust standard errors in parentheses. * Significant at 10%; ** at 5%; *** at 1%

Note: OLS regressions where the dependent variable is end-use gasoline prices (US$/liter).

Table 4: Survival Analysis on Kyoto Ratification Duration and Malapportionment

	(1)	(2)	(3)
Average Malapportionment	-10.17**	-24.96***	-23.36**
	(5.142)	(9.504)	(11.78)
Deviation from 1990 level of CO^2 or target		-2.561**	-2.305**
		(1.173)	(1.126)
Natural log of GDP per capita		2.782**	2.947**
		(1.242)	(1.305)
Polity2 score		0.366*	0.167
		(0.196)	(0.232)
Yearly Greenpeace membership per capita			0.673
			(0.621)
Petrol and coal exports as percentage GDP			-0.177
			(0.176)
Industry percentage of GDP			0.118**
			(0.0471)
EU candidate		2.315**	2.791***
		(0.904)	(1.082)
Year		-2.828**	-2.939**
		(1.364)	(1.416)
Constant	-26.10***	-104.3***	-115.8***
	(5.343)	(36.18)	(42.96)
Probability > χ^2	0.048	0.0102	0.0000
ln_p	1.862***	3.252***	3.334***
	(0.213)	(0.378)	(0.398)
Number of observations	104	99	99
Number of countries	20	19	19

Notes: Robust standard errors in parentheses. * Significant at 10%; ** at 5%; *** at 1%. These results are from a parametric survival model with a Weibull distribution. The dependent variable is the spell to ratification in months. Polity2 scores unavailable for Iceland. In Models 2 and 3, Iceland is omitted. The results are similar when using a Cox proportional hazard model.

Appendix A: Data for Gasoline Tax/Price Regressions

country	OECD	Total Gas Taxes	Pump Price	Malapportionment	GDPPC	CO^2 Emissions	Taxes, % of GDP	PR
Argentina	0		0.6	0.31285	7.18411	3.42409		1
Australia	1	0.2919	0.5341	0.16015	18.12743	17.08914	15.944	1
Austria	1	0.7517	1.15	0.0643	21.08811	7.329781	10.83	1
Benin	0		0.36	0.0319	0.27994	0.2136348		1
Bolivia	0		0.38	0.2741	0.94779	1.084749		
Botswana	0		0.38	0.1021149	2.64314	2.241135		0
Brazil	0	0.108	0.63	0.2476	3.61121	1.544518		0
Bulgaria	0		0.46	0.017077	1.56394	6.709482		
Burkina Faso	0		0.81	0.0325	0.18348	0.0617127		
Canada	1	0.2041	0.45	0.0759	20.16953	14.59159	16.518	0
Chile	0		0.53	0.23075	4.26252	3.070952		
Colombia	0		0.35	0.0662	2.46231	1.62271		
Cyprus	0		0.7515	0.014	10.56854	7.017083		1
Czech Republic	1	0.4239	0.85	0.0264	5.10044	11.73182	9.384	1
Denmark	1	0.7454	1.081	0.0524	26.59941	10.56939	30.13	
Dominican Republic	0		0.4	0.229	1.69447	2.00589		1
Ecuador	0		0.33	0.204	1.33469	1.988831		
Estonia	0		0.33	0.014	2.91867	12.606		0
Finland	1	0.8256	1.2	0.0088	18.89913	10.25389	16.526	
France	1	0.9041	1.17	0.0695	19.98969	6.208606	6.987	
Germany	1	0.824	1.12	0.1392	21.07325	10.18369	11.266	
Ghana	0		0.38	0.1782	0.22524	0.2976349		1
Greece	1	0.5735	0.88	0.0406	9.96591	7.289065	6.428	1
Guatemala	0		0.39	0.0609	1.58862	0.7156782		1
Honduras	0		0.35	0.0404	1.09849	0.6959132		1
Hungary	0	0.5205	0.74	0.0274	3.81282	5.575301	8.648	0
India	0		0.48	0.06845	0.37181	0.9780166		
Indonesia	0		0.44	0.2519343	0.82689	1.169819		1
Ireland	1	0.5977	0.96	0.0255	16.99357	9.198454	12.703	0
Israel	0		0.73	0	17.57395	9.350634		0
Italy	1	0.7741	1.18	0.0187	17.56899	7.218607	14.157	
Japan	1	0.6057	1.25	0.0843	35.43854	9.041717	10.274	
Kenya	0		0.56	0.1946	0.41669	0.273396		1
Korea, Rep.	0		0.79	0.2075	9.1591	8.257549	6.194	0

country	OECD	Total Gas Taxes	Pump Price	Malapportionment	GDPPC	CO^2 Emissions	Taxes, % of GDP	PR
Latvia	0		0.41	0.0065	2.36405	3.723731		0
Luxembourg	1	0.565	0.84	0.2271838	36.75873	20.29292	14.586	0
Malawi	0		0.65	0.1659	0.14264	0.070438		0
Mali	0		0.82	0.0522	0.21546	0.0532666		0
Mexico	1	0.1107	0.32	0.1468	4.8916	4.031466	4.146	1
Netherlands	1	0.8736	1.21	0	20.42731	8.957603	10.942	1
New Zealand	1	0.2815	0.61	0.0163	12.14808	6.829479	22.445	
Nicaragua	0		0.62	0.0596	0.66056	0.6080496		
Norway	1	0.8499	1.33	0.0657	32.21401	7.184297	14.35	1
Paraguay	0		0.44	0.02025	1.48784	0.8253438		1
Peru	0		0.68	0	1.9755	0.9847465		0
Philippines	0		0.34	0.0144562	0.91258	0.9155324		
Poland	0	0.2734	0.55	0.11015	3.41156	8.98035	11.072	1
Portugal	1	0.7273	1.0455	0.0174	9.19702	5.036858	7.937	1
Romania	0		0.29	0.05195	1.74166	5.452302		
Russian Federation	0		0.35	0.1864	1.61812	10.15001		0
Senegal	0		0.94	0.0361	0.42382	0.3828198		0
Singapore	0		0.85	0.0815281	19.35865	11.872		0
Slovak Republic	0	0.3833	0.66	0.0131	3.1335	7.618766		1
Slovenia	0		0.59	0.0166	8.07446	6.994742		0
South Africa	0	0.2352	0.51	0.13015	2.96042	9.022507		1
Spain	1	0.5794	0.89	0.1908	12.05607	5.923406	9.388	0
Sri Lanka	0		0.75	0.0483	0.70649	0.3203918		
Sweden	1	0.7726	1.17	0.011	23.5968	5.276309	18.644	
Switzerland	1	0.6836	1.02	0.18205	32.08259	5.556104	11.913	0
Tanzania	0		0.56	0.2619	0.24861	0.1184896		
Thailand	0		0.34	0.0455	2.08623	3.152024		
Turkey	1	0.4234	0.56	0.0859	3.54936	2.768312	4.753	1
United Kingdom	1	0.6246	0.92	0.0456	21.34698	9.498077	12.744	1
United States	1	0.101	0.34	0.1893	29.94164	19.53119	12.838	0
Uruguay	0		0.89	0.0169	5.78562	1.404943		1
Venezuela, RB	0	0.0257	0.0476	0.1994	5.1196	6.106445		1
Zambia	0		0.6	0.1725	0.3046	0.2342636		0