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

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Abstract: Gasoline taxes vary widely among industrialized countries, as does support for the United Nations’ effort to curtail the use of fossil fuels 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 rural voters are disproportionately represented in the political system. 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 this variation 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 account for some of 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. Please note that pre-tax price differentials are small compared to differences in taxes. Pretax prices range from $0.39 per liter in the United Kingdom to $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. That means that even though pre-tax gas prices in the U.S. are slightly higher than in 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 seems explain little of the variation. In a simple bivariate regression of GDP per capita on Kyoto ratification, the results do not approach statistical significance.\footnote{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.} 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.

The paper is organized as follows. 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) are negatively related to malapportionment. We show that countries with more malapportioned political systems tend to have lower gasoline taxes (and gasoline prices) than countries with systems that equitably represent voters across geographic areas. In
Section 4, we 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 they are less affected by the observable externalities of gasoline consumption (local air pollution, traffic congestion).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 gasoline consumption data from the U.S. States to illustrate the differential dependence on gasoline across rural and urban communities. On the Y-axis we plot

² We assume that climate change is an unobservable consequence of gasoline usage and that people require scientific knowledge to be aware it. 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 negative relationship between fuel dependence and urbanization is clearly indicated by the fitted regression line. 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 contain 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/uauccinfo.html](http://www.census.gov/geo/www/ua/uauccinfo.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 an 8.4 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). 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 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
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, 2001). 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) increases the probability of obtaining a “Strongly agree” or “Agree” response to the environmental taxes query by just under three percentage points, holding other variables in Model 3 at their means. With the confidence interval ranging from 0.01 to 0.04, this estimate is significant at the 95 percent level.

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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?”
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, but only 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 system, 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 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 idea that malapportionment is strictly associated with bicameralism.

Malapportionment has been found to have policy consequences in many studies.6
Furthermore, a substantial literature identifies malapportionment as a source of a rural bias in
public policies.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

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

7 Thies (1998) shows that malapportionment in Japan and the United States perpetuates
agricultural subsidy programs that transfer income from urban consumers to rural producers even
in the face of massive shifts of populations toward the cities. Snyder and Samuels (2004)
examine malapportionment in 19 Latin American countries and find that malapportionment has
resulted in a systematic overrepresentation of rural interests in both lower and upper chambers.
policies than nations with majoritarian electoral systems (Fredriksson and Millimet 2004). Beyond this work, here 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). 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 \(\Sigma\) 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

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8 See also Fredriksson and Millimet (2007) for a “veto players” approach to the topic.
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. As we are interested in the overall level of malapportionment in a political system, we average of the values for the lower and upper chambers, but only if the upper chamber is effective and has influence over public policy. If there is no upper chamber, or if the upper chamber is ineffectual, 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. Countries 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. 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.

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

10 Data on the effective power of upper chambers is from Tsebelis and Money (1997), who code upper chambers according to whether they have effective legislative power on financial legislation.

11 Gasoline tax data for this cross section are from 1995, the modal year for Samuels and Snyder’s measurement of malapportionment.

12 Gasoline “pump” price data are also from the IEA. As with the 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.
To control for factors that may correlate with malapportionment, we move to regression analysis. Model 1 in Table 2 provides are baseline estimate, with no controls. Model 2 controls for the level of development (with the natural log of GDP per capita) since citizens in richer countries might prefer higher environmental taxes. Model 3 includes a control for dependence on fossil fuels with country CO$_2$ emissions, measured in metric tons per capita. The idea here is that preferences for gasoline taxes might differ nationally, due to variation in dependence on fossil fuels. The final model, Model 4, includes a dummy variable equal to 1 for countries with proportional representation electoral systems. According to Fredriksson and Millimet (2004), PR systems tend to produce higher environmental taxes than majoritarian systems.

Our variable of interest remains negative and significant in all models. While income per capita and fossil fuel dependence have relatively large and statistically significant effects, PR does not. Table 3 reports results using end-use gasoline prices (pump prices) instead of gas taxes as the dependent variable. The results remain largely the same.

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 they are magnified by malapportioned political institutions. In this section, we hypothesize that the same determinants of gasoline taxes across countries should be able to predict other environmental policies. If limiting the emission of greenhouse gases is 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

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$^{13}$ Data income per capita and CO$_2$ emissions are from the World Bank’s World Development Indicators. The PR dummy is from the World Bank’s Database on Political Institutions.

$^{14}$ 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 that 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 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 heavily 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.\textsuperscript{15} While signing the treaty may be done by the head of state, ratification requires legislative approval in most of the Annex 1 countries. While 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.

Zarhan et al. (2007) focus on hypotheses derived from sociology’s ecological modernization theory (EMT). They argue that modernization, the phenomena that many fault for the degradation of the environment, is important for increasing environmentally friendly policy. 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

\textsuperscript{15} 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.
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 hold 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.

To test our argument about the malapportionment bias, we use a replication dataset from Von Stein (2008).\textsuperscript{16} 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

\textsuperscript{16} The results found here are robust to similar models produced with replication data from Neumayer (2007) and Zarhan et al. (2007).
is “Malapportionment,” measured as before (see the discussion in Section 3).\(^{17}\) 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 the effect to be muted because of the restricted sample. Additionally, Neumayer
(2002) finds that democracies are more likely to make environmental commitments than non-
democracies. While 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.

\(^{17}\) 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.
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 are shifts, rather than changes in the slope.

5. Conclusion

We have shown that rural citizens are more dependent on gasoline than urban residents (in higher income countries) 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. Yet since rural residents are in the minority in developed countries, we do not expect their preference for low environmental taxes to have a policy effect unless the political system is biased on their behalf. Our core argument is that malapportionment creates such a bias and thereby skews environmental policy toward the interests of rural residents.

To evaluate this claim, we regressed two dependent variables that proxy for “environmental policy” on malapportionment. Findings from both analyses support our argument. First, nations with malapportioned political systems have lower gasoline taxes—and, hence, 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 are the first to show that political institutions—specifically, malapportionment—shape environmental policy outcomes.
References


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.
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.”
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_2009_0826corr.pdf.
Figure 7: Survival Function Plotted with Varying Levels of Malapportionment
### Table 1: Support for Environment Taxes and City Size

<table>
<thead>
<tr>
<th>Support for Environment Taxes</th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>City Size</td>
<td>0.035</td>
<td>0.017</td>
<td>0.016</td>
</tr>
<tr>
<td></td>
<td>(0.002)***</td>
<td>(0.005)***</td>
<td>(0.005)***</td>
</tr>
<tr>
<td>Education Attainment</td>
<td>0.097</td>
<td>0.091</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.005)***</td>
<td>(0.005)***</td>
<td></td>
</tr>
<tr>
<td>Ideology</td>
<td>-0.034</td>
<td>-0.027</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.005)***</td>
<td>(0.005)***</td>
<td></td>
</tr>
<tr>
<td>Local Air Pollution</td>
<td>0.059</td>
<td>0.038</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.010)***</td>
<td>(0.010)***</td>
<td></td>
</tr>
<tr>
<td>Concern for Global Warming</td>
<td></td>
<td>0.248</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.016)***</td>
<td></td>
</tr>
</tbody>
</table>

Observations                  | 35,667 | 10,198 | 10,079 |
Pseudo R²                     | 0.003  | 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

<table>
<thead>
<tr>
<th></th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Malapportionment</td>
<td>-1.809</td>
<td>-1.738</td>
<td>-1.468</td>
<td>-1.664</td>
</tr>
<tr>
<td></td>
<td>(0.592)**</td>
<td>(0.453)**</td>
<td>(0.410)**</td>
<td>(0.512)**</td>
</tr>
<tr>
<td>ln GDP per capita</td>
<td>0.171</td>
<td>0.224</td>
<td>0.222</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.032)**</td>
<td>(0.026)**</td>
<td>(0.023)**</td>
<td></td>
</tr>
<tr>
<td>CO² per capita</td>
<td>-0.022</td>
<td>-0.023</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.009)**</td>
<td>(0.009)**</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Proportional Representation</td>
<td>0.013</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.08)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Constant</td>
<td>0.683</td>
<td>-0.938</td>
<td>-1.268</td>
<td>-1.233</td>
</tr>
<tr>
<td></td>
<td>(0.059)**</td>
<td>(0.299)**</td>
<td>(0.245)**</td>
<td>(0.238)**</td>
</tr>
<tr>
<td>Observations</td>
<td>30</td>
<td>30</td>
<td>30</td>
<td>22</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.25</td>
<td>0.55</td>
<td>0.65</td>
<td>0.71</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th></th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Malapportionment</td>
<td>-1.029</td>
<td>-0.804</td>
<td>-0.742</td>
<td>-0.744</td>
</tr>
<tr>
<td></td>
<td>(0.345)***</td>
<td>(0.314)**</td>
<td>(0.307)**</td>
<td>(0.355)**</td>
</tr>
<tr>
<td>ln GDP per capita</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.097</td>
<td>0.143</td>
<td>0.129</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.022)***</td>
<td>(0.029)***</td>
<td>(0.033)***</td>
<td></td>
</tr>
<tr>
<td>CO2 per capita</td>
<td></td>
<td></td>
<td>-0.021</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(0.008)**</td>
<td></td>
</tr>
<tr>
<td>Proportional</td>
<td></td>
<td></td>
<td></td>
<td>-0.053</td>
</tr>
<tr>
<td>Representation</td>
<td></td>
<td></td>
<td></td>
<td>(0.068)</td>
</tr>
<tr>
<td>Constant</td>
<td>0.773</td>
<td>-0.044</td>
<td>-0.322</td>
<td>-0.182</td>
</tr>
<tr>
<td></td>
<td>(0.054)***</td>
<td>(0.194)</td>
<td>(0.225)</td>
<td>(0.272)</td>
</tr>
<tr>
<td>Observations</td>
<td>67</td>
<td>67</td>
<td>67</td>
<td>46</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.09</td>
<td>0.34</td>
<td>0.38</td>
<td>0.33</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th></th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average Malapportionment</td>
<td>-10.17**</td>
<td>-24.96***</td>
<td>-23.36**</td>
</tr>
<tr>
<td></td>
<td>(5.142)</td>
<td>(9.504)</td>
<td>(11.78)</td>
</tr>
<tr>
<td>Deviation from 1990 level of</td>
<td>-2.561**</td>
<td>-2.305**</td>
<td></td>
</tr>
<tr>
<td>CO2 or target</td>
<td>(1.173)</td>
<td>(1.126)</td>
<td></td>
</tr>
<tr>
<td>Natural log of GDP per capita</td>
<td>2.782**</td>
<td>2.947**</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(1.242)</td>
<td>(1.305)</td>
<td></td>
</tr>
<tr>
<td>Polity2 score</td>
<td>0.366*</td>
<td>0.167</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.196)</td>
<td>(0.232)</td>
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</tr>
<tr>
<td>Yearly Greenpeace membership</td>
<td></td>
<td>0.673</td>
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</tr>
<tr>
<td>per capita</td>
<td></td>
<td>(0.621)</td>
<td></td>
</tr>
<tr>
<td>Petrol and coal exports as</td>
<td>-0.177</td>
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<td></td>
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<tr>
<td>percentage GDP</td>
<td></td>
<td>(0.176)</td>
<td></td>
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<tr>
<td>Industry percentage of GDP</td>
<td>0.118**</td>
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<tr>
<td></td>
<td>(0.0471)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>EU candidate</td>
<td>2.315**</td>
<td>2.791***</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.904)</td>
<td>(1.082)</td>
<td></td>
</tr>
<tr>
<td>Year</td>
<td>-2.828**</td>
<td>-2.939**</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(1.364)</td>
<td>(1.416)</td>
<td></td>
</tr>
<tr>
<td>Constant</td>
<td>-26.10***</td>
<td>-104.3***</td>
<td>-115.8***</td>
</tr>
<tr>
<td></td>
<td>(5.343)</td>
<td>(36.18)</td>
<td>(42.96)</td>
</tr>
<tr>
<td>Probability &gt; $\chi^2$</td>
<td>0.048</td>
<td>0.0102</td>
<td>0.0000</td>
</tr>
<tr>
<td>ln_p</td>
<td>1.862***</td>
<td>3.252***</td>
<td>3.334***</td>
</tr>
<tr>
<td></td>
<td>(0.213)</td>
<td>(0.378)</td>
<td>(0.398)</td>
</tr>
<tr>
<td>Number of observations</td>
<td>104</td>
<td>99</td>
<td>99</td>
</tr>
<tr>
<td>Number of countries</td>
<td>20</td>
<td>19</td>
<td>19</td>
</tr>
</tbody>
</table>

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.