

The Electoral Politics of Energy

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Abstract

How do political institutions affect energy policy and climate change? I argue that electoral institutions exert a strong influence on energy conservation policies. Energy conservation is more feasible under electoral arrangements, such as non-majoritarian systems, which allow for the imposition of high, diffuse costs on the general public. This remedies an important roadblock to greenhouse gas emissions mitigation in democratic states – public opposition to policies that raise energy prices. I test this theory empirically using a mixed methods approach, including analysis of a new panel dataset of transportation trends in OECD countries, synthetic matching, and an in-depth qualitative examination of energy policy in Japan. The findings have significant implications for our understanding of the policy effects of electoral institutions and the politics of energy.

What explains variation in energy and climate change policies? After several decades of relative neglect, the politics of energy is reemerging as a major substantive area of inquiry (Hughes and Lipsky 2013; Hancock and Vivoda 2014). The threat of global climate change has catalyzed international cooperation and academic work on environmental agreements and institutions (Stone and McLean 2004; von Stein 2008; Bättig and Bernauer 2009; Keohane and Victor 2011). However, broad, international climate change cooperation has achieved mixed results at best (Victor 2001; Harris 2007). This has shifted attention toward domestic political processes that might facilitate energy conservation and emission mitigation policies (Urpelainen 2009; Hughes and Lipsky 2013; Aklin and Urpelainen 2013).

In this article, I will argue that energy conservation and CO₂ mitigation are more feasible under electoral arrangements that allow for particularistic redistribution through the imposition of high, diffuse costs on the general public. An important roadblock to energy conservation in democratic states is public opposition to policies that impose high prices on energy-intensive activities, particularly in the transportation sector (Bättig and Bernauer 2009). In electoral systems that are relatively more responsive to consumers, such as majoritarian systems (Rogowski and Kayser 2002; Chang et al. 2010; Rosenbluth and Thies 2010), resistance to higher prices diminishes the ability of governments to encourage energy conservation through price incentives. Under less responsive arrangements, such as proportional representation systems, the loss of political support from consumers can be offset by the targeted redistribution of the revenues or rents generated from higher energy prices.

This article contributes to a growing literature on the policy effects of electoral systems (Persson and Tabellini 2002; Rosenbluth and Schaap 2003; Iversen and Soskice 2006; Chang and Golden 2007; Chang et al. 2008; Carey and Hix 2013; Catalinac 2016). I show that variation

in electoral institutions is associated with predictable patterns in substantively important outcomes, such as how much energy the citizens of a country use; how far they travel; their likelihood of using automobile or rail; and the impact of their activities on the environment.

I test the theory both quantitatively and qualitatively. I will present quantitative evidence based on a new dataset on energy and transportation outcomes among OECD countries collected from primary sources. Consistent with my theory, countries with electoral systems that favor concentrated interests over the unorganized voter – i.e., countries with low Cox thresholds and non-majoritarian institutions – are characterized by higher diffuse costs on energy use (gasoline and electricity prices), lower per capita travel distances, higher public transportation share of total travel, lower automobile fuel intensity, lower transportation energy intensity, lower overall energy intensity, and lower CO₂ emissions intensity. Over-time variation also provides support for the theory – countries that enacted electoral reform over the past three decades have seen energy outcomes shift as predicted. I will also present a detailed case study of Japan, which enacted electoral reform in 1994, using both the synthetic control method and qualitative case study evidence. The empirical evidence consistently supports my theoretical predictions.

Theory: The Electoral Context of Energy Policy

Since the Arab Oil Embargo of 1973, governments have intervened extensively in the energy sector in order to address the negative externalities of unfettered energy consumption. Policymakers have pursued energy conservation efforts in order to mitigate the risks of supply shocks (Deese and Nye 1981; Yergin 2006; Jacobson 2009) as well as to reduce pollution and greenhouse gas emissions associated with fossil fuel consumption (Nordhaus 1994; Bernauer 2013; Aklin and Urpelainen 2013).

Public policy to encourage energy conservation beyond what would be achieved by the market necessarily implies the distortion of private outcomes and the imposition of costs on some members of society (Stern 2008). In some cases, costs are concentrated, as when an energy-intensive industry, such as steel, is targeted for regulation or taxation. However, oftentimes costs are diffuse and affect the decentralized behavior of a large numbers of energy users – e.g. decisions about thermostat temperature settings or paying a premium for an energy-efficient appliance (Strbac 2008). The transportation sector predominantly falls into the latter category, as many of the decisions that affect energy consumption – how far to travel, whether to drive or ride the train, what kind of automobile to purchase – are decentralized, individual-level decisions (Meyer 1999). Government manipulation of such decisions inevitably runs up against questions of individual freedoms and mobility. Perhaps for this reason, democratic societies have faced particular difficulties reigning in energy consumption in the transportation sector (Bättig and Bernauer 2009). Electricity use also has similar features – although governments can regulate power generation and encourage investment in alternative energy sources, electricity consumption is ultimately determined by the decentralized decisions of numerous end users (Lindén et al. 2006).

The central premise of my theory is that some domestic institutional arrangements are more conducive to energy conservation and greenhouse gas mitigation than others. In particular, I focus on the incentives generated by the electoral system. Electoral systems vary according to the incentives generated for politicians to serve either organized interest groups or the unorganized voter (Denzau and Munger 1986; Persson and Tabellini 2002; Rogowski and Kayser 2002; Bawn and Thies 2003; Grossman and Helpman 2005; Weinberg 2012). In turn,

electoral incentives can either be compatible or incompatible with the imposition of diffuse costs on the energy-consuming public.

Under electoral systems that reward politicians for appealing narrowly to organized interests, it is relatively unproblematic to impose diffuse costs for the purpose of encouraging energy conservation. What electoral support is lost from the general public can be compensated by allowing organized interests to benefit from higher prices. There are two principal mechanisms to reward organized groups. First, revenues generated from taxes levied on energy-intensive activities can be redistributed to targeted groups. For example, it is common for revenues associated with gasoline taxes to be earmarked for road construction and maintenance. In theory, this reflects the principle that heavy users of roads should contribute to their upkeep. However, in practice, such arrangements are heavily redistributive, with resources flowing diffusely from automobile users – most residents in developed countries – to the construction industry and residents in agricultural communities proximate to underutilized roads (Lipsy 2012). Second, governments may allow organized interest groups to capture rents associated with high prices, for example by allowing electricity utilities to mark up prices (Green and Newbery 1992; Bernard and Roland 1997; Joskow and Kahn 2001). In electoral contexts that necessitate broad, programmatic appeal, such redistributive mechanisms less effectively compensate for support lost from imposing high prices on the general public.

Operationalization of the Independent Variable

My theory predicts that we should observe more robust energy conservation policies in countries where political institutions tilt the scales against diffuse consumers. In order to

operationalize this proposition for quantitative analysis in a cross-national setting, I consider two measures associated with characteristics of electoral institutions. The first measure is the Cox threshold. The Cox threshold is defined as:

$$\bar{s} = \sum_{v=1}^m s_v/m$$

where s is a scoring rule, m is the number of competitors, and v is the number of noncumulative votes in an election. The concept of the Cox threshold was developed by Cox (1990) and Myerson (1993) and operationalized for national elections by Park and Jensen (2007). Electoral systems with low Cox thresholds tend to drive candidates towards narrow appeal to organized interest groups, because elected office can be secured with small shares of the total vote. Park and Jensen (2007) find that the Cox threshold is closely related to the political influence of agricultural interests in OECD countries. Hence, my theoretical expectation is that countries with low Cox thresholds will be better able to address the negative externalities of energy consumption by imposing high costs on diffuse energy consumers. Although politicians in such countries sacrifice political support from energy consumers, higher prices create opportunities to win elections by rewarding organized groups through redistributive taxation or rent provision.

The second measure I use is a dichotomous indicator of proportional/majoritarian electoral systems.² With the exception of lopsided one-party dominated political systems, majoritarian electoral rules tend to discourage the targeting of narrow interests due to large seat-vote disproportionality – i.e., the marginal value of votes is higher compared to the marginal value of support attainable from organized interests (Rogowski and Kayser 2002; Chang et al. 2010). In addition, proportional rules are more forgiving of candidates that harm their personal reputation by catering to organized interests, as party reputation tends to trump personal

² I use the variable coded by Chang et al (2010), which is in turn based on Golder (2005).

reputation (Bawn and Thies 2003). Consistent with these theories, there is a strong relationship between low consumer prices (i.e., limited monopoly rents for organized producers) and majoritarian electoral systems (Chang et al. 2010). Hence, politicians in majoritarian electoral systems are likely to face greater relative difficulty implementing policies that encourage energy conservation by imposing high, diffuse costs on the general public.

Each of these measures has distinct advantages and disadvantages. The Cox threshold is a continuous measure, making it more likely to pick up subtle variations in electoral institutions that the dichotomous PR variable fails to capture. It is therefore useful for the cross-sectional analysis as I illustrate below. However, the Cox threshold is less responsive to changes in electoral institutions over time. As the measure is derived from party competition during elections, it tends to update with a considerable lag after episodes of electoral reform: e.g., in Italy and Japan, unviable parties continued to contest elections for several cycles after a shift to majoritarian rules. The dichotomous PR variable is therefore more likely to capture sharp shifts in incentives associated with electoral reform.

Predictions

Table 1 presents my core theoretical predictions. I predict that countries with electoral incentives conducive to less consumer influence relative to concentrated interest groups – i.e. low Cox thresholds and proportional representation – will be characterized by higher prices for decentralized energy consumption. In particular, I will focus on prices related to the consumption of automobile transportation and electricity. These higher prices serve two

purposes: 1. facilitate energy conservation by discouraging diffuse energy consumption; and 2. generate rents or revenues to reward and obtain political support from organized interest groups.

Table 1: Empirical Predictions

	Energy Prices	Transport Distance	Rail & Bus Share	Automobile Energy Intensity	Energy Intensity, Transport	Energy Intensity, Economy	CO ₂ Emissions Intensity
Low Cox Thresholds; PR Systems	+	-	+	-	-	-	-

My theory also generates several additional predictions that can be tested with disaggregated energy use data. Policies that make motorized transportation – particularly energy-intensive transportation – expensive will have observable effects on the behavior of a country’s citizens. In low-Cox-threshold/PR countries, I predict that citizens will travel shorter overall distances by, among other things, residing closer to locations of employment to reduce commute distance and, ceteris paribus, opting for geographically proximate venues in their daily lives for purposes such as shopping and entertainment. Citizens will also opt for travel by less energy intensive public transportation, primarily rail or bus. Finally, when they travel by automobile, citizens will travel with lower unit-level energy intensity due to strong incentives to own fuel-efficient automobiles rather than gas guzzlers.³ In combination, these factors imply lower energy intensity in the transportation sector.

How do my theoretical predictions translate to aggregate energy outcomes? In electoral systems that create incentives to appeal broadly to voters, one might imagine a different, but equally effective, energy conservation policy mix – i.e., politicians impose heavy, concentrated

³ Higher public transportation share may also decrease unit-level energy intensity in the transportation sector by reducing traffic congestion, which tends to reduce realized fuel economy.

costs on energy-intensive organized interests, such as heavy industry and manufacturing, and use the revenues to support programs favored by the general population. As a practical matter, this is not a feasible political strategy for several reasons. First, even in majoritarian systems, a redistributive mechanism with large, highly focused costs and small, diffuse benefits is hampered by severe collective action problems (Olson 1965). Second, it is difficult for governments to impose punishing costs on energy-intensive industry due to the fact that most industrial operations are internationally footloose (Rodrik 1997). While an automobile driver facing high gasoline taxes is unlikely to contemplate moving abroad, the owner of an energy-intensive manufacturing plant facing onerous government policies can credibly threaten international relocation.⁴ Consistent with this, industrial energy intensity has generally converged cross-nationally over time (Mulder and de Groot 2012) – unlike diffuse consumption, it is difficult for countries to unilaterally impose high costs on industry. Third, even if countries with electoral incentives favoring the diffuse consumer targeted industry, direct industrial CO₂ emissions are generally small in proportion to emissions associated with diffuse consumption.⁵ Due to these factors, I predict that electoral systems that favor organized interests over diffuse voters will be associated with relatively lower energy intensity and CO₂ emissions intensity in aggregate, i.e., lower energy consumption and emissions for each unit of economic output.

My theory also produces several observable implications that allow us to clearly differentiate the predictions from other potential mechanisms that might lead to an association

⁴ This is less of an issue for nontradable goods. However, most nontradable goods are produced in the service sector (Iversen and Soskice 2010), which is typically not energy intensive (Mulder and de Groot 2012).

⁵ For example, in the United States in 2009, the sectoral contributions to CO₂ emissions were industry (16%), transportation (34%), and electricity (40%), while for the world as a whole they were industry (20%), transportation (23%), and electricity and heat (41%). The IEA groups electricity and heat together as a separate category, while the U.S. does not. Sources: U.S. Energy Information Administration, *Monthly Energy Review* (April 2010), Tables 12.2 - 12.6; International Energy Agency, *CO₂ Emissions from Fuel Combustion Highlights*, 2011 Edition, 9.

between electoral institutions and energy outcomes. I will discuss these in the robustness checks and supporting information below.

Data Discussion

My dataset contains a range of indicators related to energy outcomes in OECD countries from 1970-2010. Several of these are aggregate indicators collected by the International Energy Agency (IEA), namely gasoline and electricity prices, energy intensity, and CO₂ emissions intensity (International Energy Agency 2016). However, to analyze disaggregated energy usage in the transportation sector, I use a new dataset collected from national sources on travel distances and energy consumption across transportation modes.⁶ The dataset includes all OECD countries, but not all countries are represented in the analysis due to missing data for specific indicators.⁷ In the transportation sector, we can examine not only aggregate energy intensity, but also disaggregated components, namely total distances traveled, transportation mode share, and energy intensity by mode.⁸ This disaggregation provides additional variables with which to test my predictions and build the case in support of my theory.

For the price measures, I focus on gasoline and electricity, as these are the most readily available cross-national measures pertinent to decentralized energy consumption in OECD countries. As I will detail below, for specific countries, alternative measures may be more important. Nonetheless, gasoline and electricity prices have the advantage of being substantively important but also clearly comparable across countries. Other measures, such as automobile

⁶ This data was collected in collaboration with Lee Schipper. Rosalind Boone deserves particular mention for excellent research assistance.

⁷ E.g., for the disaggregated transportation data, fourteen OECD countries are represented, specifically Australia, Canada, Denmark, Finland, France, Germany, Italy, Japan, the Netherlands, New Zealand, Norway, Sweden, the United Kingdom, and the United States.

⁸ For an overview, see Ang (2000).

taxes and tolls, are assessed using a variety of methods cross-nationally, making it more difficult to draw direct comparisons.⁹

Energy intensity and CO₂ emissions intensity are aggregate measures that capture the overall energy usage patterns of a country. Energy intensity measures how much energy a country consumes per unit of economic activity.¹⁰ CO₂ emissions intensity is an analogous measure, in which the nominator is replaced with CO₂ emissions. CO₂ is the most important greenhouse gas, accounting for 76% of global greenhouse gas emissions (IPCC 2014). In theory, CO₂ emissions intensity can diverge from energy intensity, as the measure depends not only on energy intensity but also on the carbon intensity of a country's energy consumption. For example, if a country relies heavily on non-fossil fuel energy sources, it may have a lower CO₂ emissions intensity than suggested by its energy intensity. However, as a practical matter, the measures are highly correlated due to the fact that the lion's share of both energy consumption and CO₂ emissions are due to the use of fossil fuels. In particular, although there is modest cross-national variation in the energy mix for power generation, the transportation sector in essentially all major economies is heavily reliant on fossil fuels.

Among the disaggregated measures, total distance traveled is expressed as the average per capita distance traveled on all forms of motorized transportation by individuals residing within a country's borders. This includes travel by automobile, motorcycle, bus, rail, water, and air. Since all forms of motorized transportation consume energy – whether it is generated onboard or obtained through the electric grid – greater travel distances are *ceteris paribus* associated with greater energy consumption.

⁹ E.g. Automobile taxes can be assessed according to unit, weight, automobile type, sticker price, emissions, etc.

¹⁰ The measure I use is kg of oil equivalent / GDP measured in 2005 PPP US\$.

Another critical component of energy consumption in the transportation sector is mode share. In particular, rail and bus travel tends to be vastly superior in energy efficiency (distance traveled per unit of energy consumed) compared to other forms of transportation cross nationally. For example, in Japan, automobile transport consumes about 6 times as much energy to carry a passenger the same distance as a train and 4 times the energy of buses. Even in the United States, where low ridership diminishes the efficiency of public transportation, automobiles consume 2-3 times the energy of rail and bus.¹¹ Hence, countries with high rail and bus ridership tend to consume less energy for transportation.

Finally, there is also cross-national variation in energy intensity within travel modes. As discussed above, the energy intensity of public transportation depends on ridership. However, the energy intensity of automobiles is generally more important, as automobiles consume the largest share of transportation energy in most countries. My dataset contains information on realized fuel economy. Realized fuel economy tends to be higher when drivers purchase fuel efficient automobiles, but also when there is less congestion due to fewer cars being on the road (Millard-Ball and Schipper 2011).

Cross-Sectional Analysis

Before moving to the panel data, I begin by analyzing cross-sectional data for 1990. 1990 is a reasonable starting point for analysis for several reasons. First, electoral systems were relatively stable prior to the 1990s,¹² and energy outcomes generally change gradually. We would not expect a country that changes its electoral system from majoritarian to PR to

¹¹ Based on data for 2005.

¹² France adopted PR in 1986 but quickly reverted to a majoritarian system in 1988.

immediately converge to PR energy outcomes. Many energy-related decisions are made with a long-term timeframe, such as what type of car or appliance to purchase, opting for central heating, or choosing to live in a suburb or close to public transportation. Even concerning policy measures, we would expect a gradual shift after electoral reform, because immediate, large-scale shifts in energy prices are not practical – e.g., raising gasoline taxes drastically in a country with limited public transportation infrastructure would conserve energy but also lead to severe economic disruptions. The impact of electoral reform on energy policy will be examined using panel data, which incorporates more recent years, in the following section. Second, by 1990, energy conservation policies proposed in response to the 1970s oil shocks had sufficient time to take effect. In addition, by the mid-1980s, global oil prices had declined considerably from their peak levels during the oil shocks, creating scope for differentiation in outcomes according to domestic energy policy choices. During the 1980s, several countries responded to declining oil prices by rolling back energy conservation measures, symbolized by U.S. President Reagan’s removal of the rooftop solar panels on the White House installed during the Carter administration (Biello 2010). Hence, we would expect a relatively tight relationship between the predicted outcomes and electoral institutions by 1990.

Figure 1 presents a basic bivariate scatter plot of the Cox threshold and CO₂ intensity in 1990. High CO₂ intensity indicates that, for every unit of economic output produced, a country tends to emit a greater quantity of CO₂. Although the relationship is imperfect, the figure illustrates a positive association between the Cox threshold and CO₂ intensity in the raw data ($r = 0.74$): countries with electoral institutions that magnify the political influence of consumers are associated with greater CO₂ emissions relative to economic activity.

Figure 1: Electoral Institutions and CO₂ Intensity, 1990

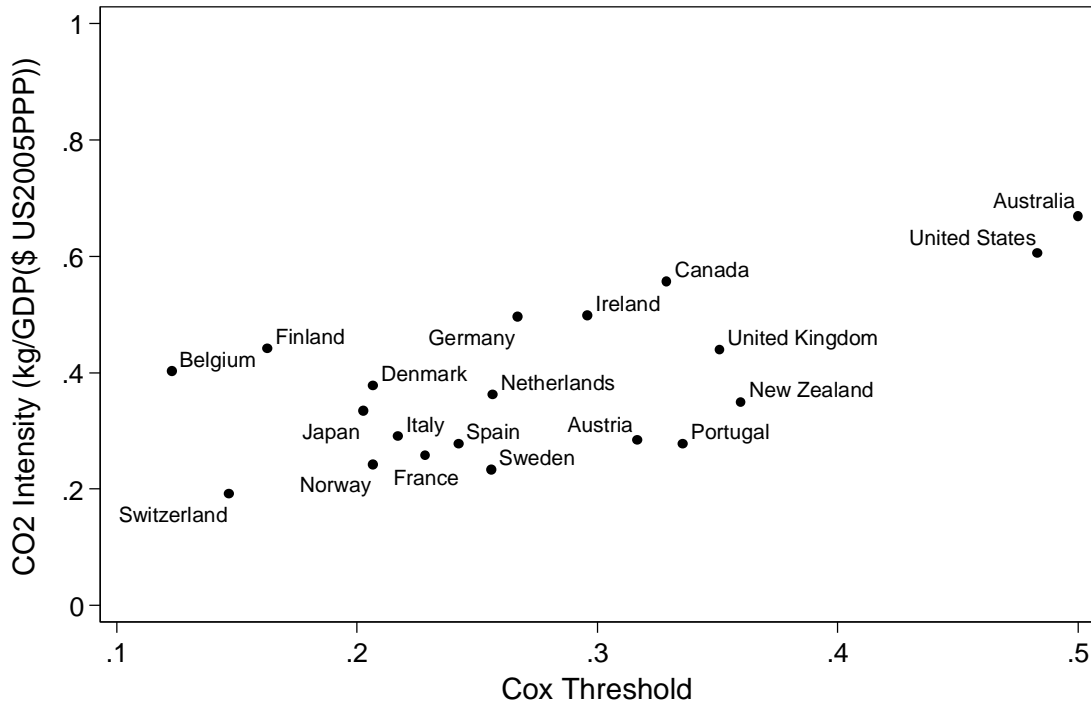
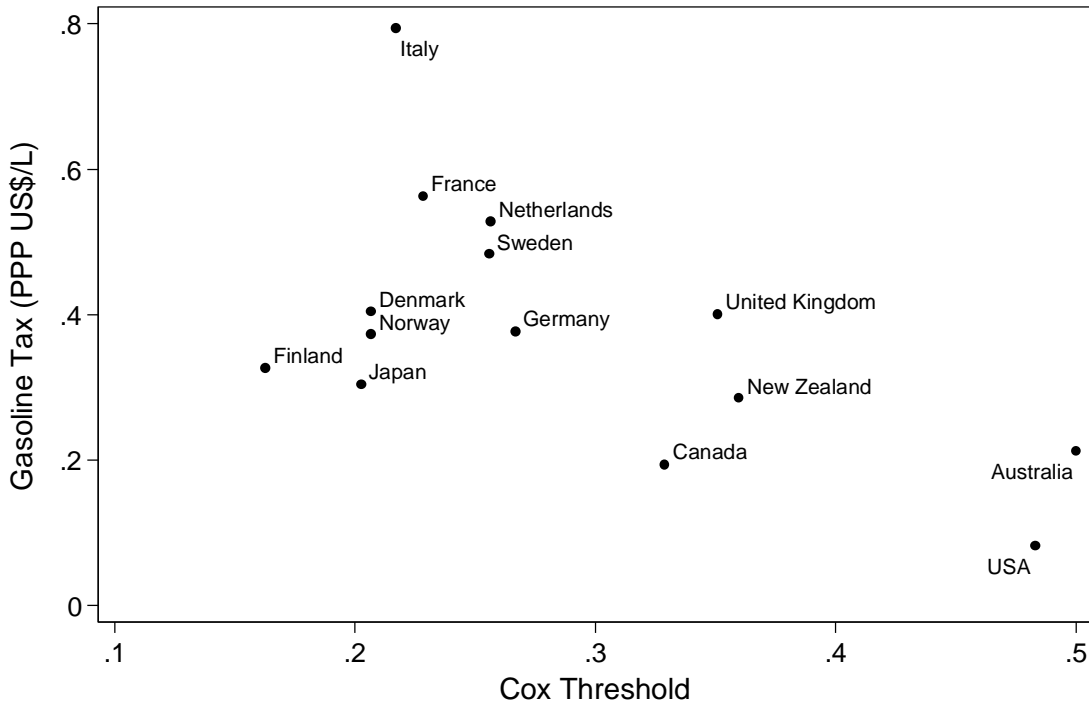


Figure 2 presents a similar scatterplot, this time replacing the y-axis with gasoline tax rates. My theory predicts that governments with higher Cox thresholds – i.e. electoral systems necessitating broad appeal to the median voter within districts – should have a more difficult time raising gasoline prices for the purposes of promoting energy conservation. The raw data is broadly consistent with this proposition, with gasoline tax rates lowest in countries with high Cox thresholds. Note that although gasoline taxes are readily available and therefore amenable to cross-national comparison, they are not the only means of raising the cost of automobile operation. As I will discuss below, focusing only on gasoline taxes understates the cost of automobile operation in countries that rely on alternative measures such as highway tolls or automobile taxes. In particular, the low vertical positions of Japan and Finland in Figure 2 are

misleading: Japanese tolls and automobile taxes were among the highest in the world in 1990, and automobile registration fees in Finland have been among the highest in Europe.

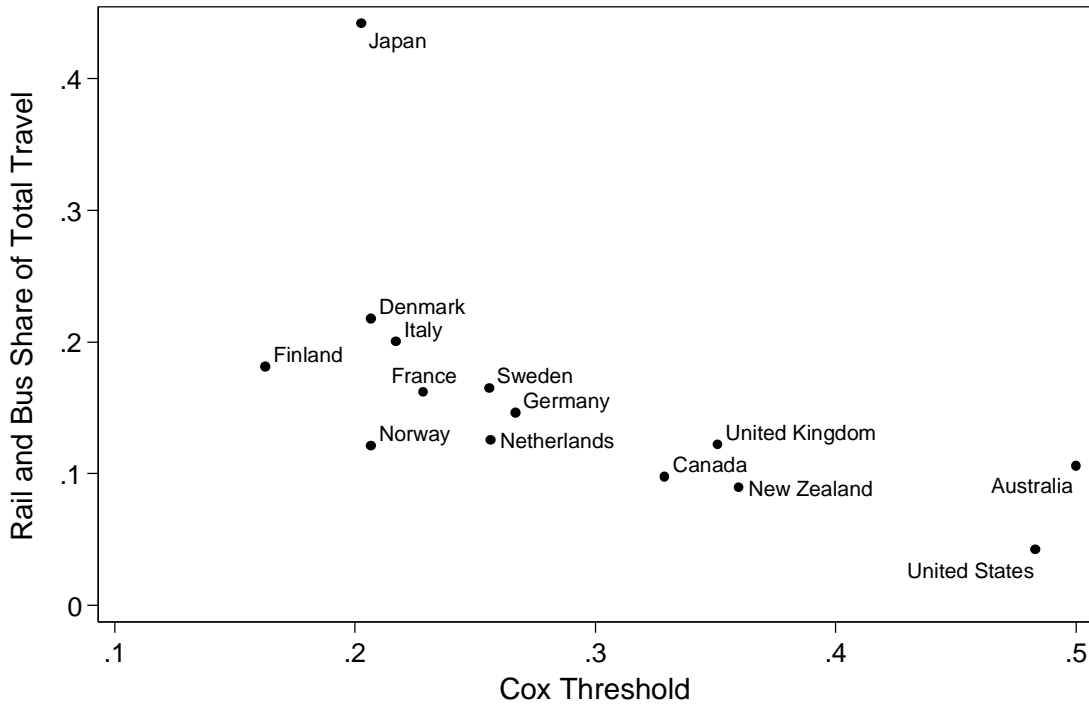
Figure 2: Electoral Institutions and Gasoline Taxes, 1990



Note: Gasoline tax rates do not perfectly capture the cost of automobile operation cross-nationally; e.g. Finland and Japan, which had relatively low gasoline tax rates in 1990, imposed high fees on automobile ownership and operation.

Figure 3 is a bivariate scatter plot of public transportation (i.e. rail/bus) share of total travel against the Cox threshold. As the figure illustrates, there is a general inverse relationship between the Cox threshold and rail/bus share. This is consistent with my theory: countries with lower Cox thresholds tend to be characterized by more travel on energy efficient modes of transportation. Japan is an outlier with a high share of public transportation compared to other countries, but the inverse relationship is visible even if Japan is excluded.

Figure 3: Electoral Institutions and Public Transportation Share of Total Travel, 1990



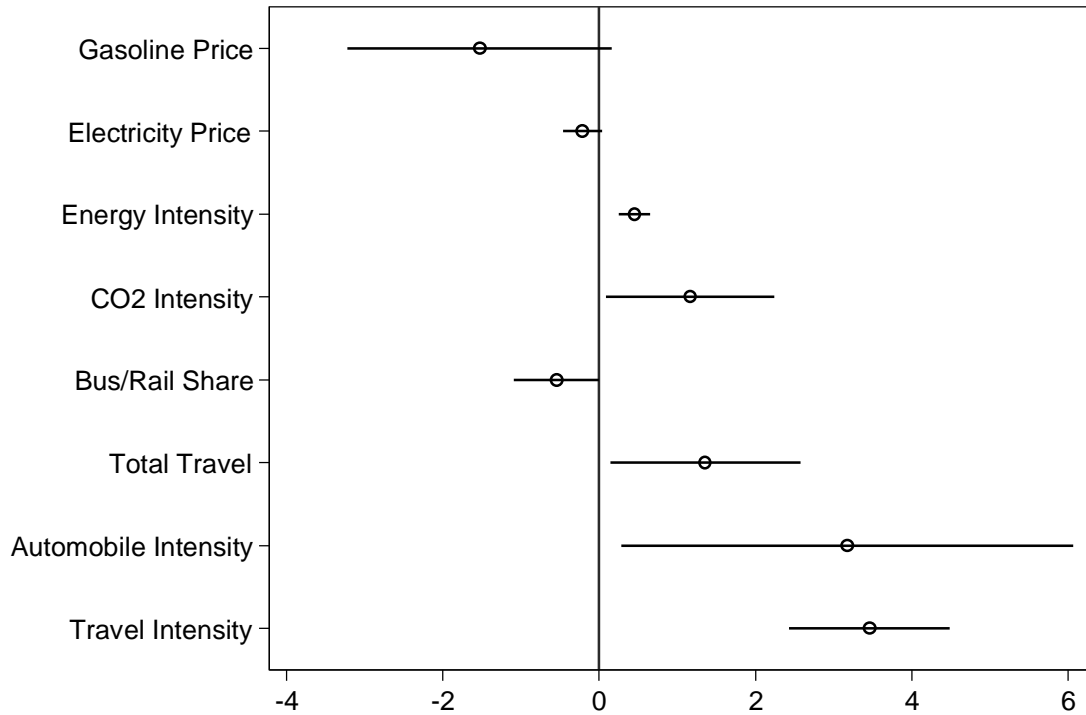
While the figures above are useful starting points, they are also suggestive of several alternative explanations. As with other studies of advanced industrialized countries, the cross-national data offers limited degrees of freedom for the purposes of statistical analysis. Nonetheless, it is helpful to consider several potential confounders. One confounder suggested by the figures is Anglo-Saxon heritage, as indicated by the association of countries such as Canada, the United States, United Kingdom, Australia, and New Zealand with high CO₂ intensity, low gasoline taxes, and greater reliance on automobile transportation. I will return to these types of country-specific, unchanging factors in the subsequent section, as they are best addressed by analyzing panel data that allows us to examine the impact of institutional shifts within countries.

Among variable factors, one obvious control suggested by the figures above is population density. Large countries with dispersed populations, such as the United States and Australia, may be more prone to energy intensive air and automobile transportation or energy losses in electric power transmission. I therefore include population density as a control variable.¹³ In alternate specifications, I also tried land area and population independently, and this had no bearing on the substantive results. I also include a proxy for economic development – GDP per capita – since wealthy countries may be characterized by greater rates of automobile ownership or larger houses that require more energy for heating and cooling. It is also possible that local climate conditions affect energy usage patterns. Cold climates, such as in Canada, might be associated with greater energy use for heating and higher share of private automobile transportation due to the impracticality of waiting outdoors for public transportation. In alternative specifications, I used variation in daily temperatures, cloud cover, and annual precipitation, and the substantive results were unchanged. Countries may also vary in the general presence of concentrated interest groups with a stake in energy policy outcomes, independent of electoral institutions. Energy-intensive industries may lobby their governments to maintain energy prices at low levels to limit input costs. Oil producing countries may face lobbying against energy conservation policies from primary energy producers. I therefore include proxies for each of these factors in the models.¹⁴ In alternative specifications, I also included controls for trade openness and size of the transportation sector, with no change in the substantive results.

¹³ This variable is measured as 100,000 people per square km.

¹⁴ Specifically, I use manufacturing and mining share of GDP and the log of oil production.

Figure 4: The Cox Threshold and Energy Policy Outcomes, 1990



Note: the dots represent coefficients, and lines 95% confidence intervals, from OLS model specifications where the Cox Threshold is the key independent variable and the dependent variable is listed vertically. Each model is estimated with robust standard errors and includes the following control variables: population density, GDP/capita, annual mean temperature, manufacturing share of GDP, log of oil production. Regression tables are available in the Supporting Information.

Figure 4 presents the substantive results of interest from cross-national OLS regressions for the eight dependent variables associated with energy policy outcomes. The models are for 1990 and include the control variables described above. The full regression tables with details are available in Supporting Information I, and analogous substantive results were obtained when omitting all of the control variables as well as including each control variable individually in the models. The results are broadly consistent with the theoretical predictions. Countries with high Cox thresholds are associated with lower gasoline and electricity prices and greater overall energy and CO₂ intensity. In other words, countries where electoral incentives favor consumers tend to impose lower prices on energy consumption, use more energy, and emit more CO₂ in

relation to GDP. Transportation outcomes are also broadly consistent with my predictions. High Cox thresholds are associated with low bus/rail share, longer total distances traveled, more energy intensive automobiles, and higher overall transportation intensity. In electoral contexts that favor consumers, transportation users tend to travel longer distances in energy inefficient forms of transportation. In Supporting Information II, I provide analogous results using the dichotomous indicator for PR electoral systems: although the results are estimated with less precision using the dichotomous PR variable, the associations between PR and the energy outcomes variables are all in the direction predicted by my theory.

Panel Analysis

Electoral systems do not change very often. However, among the countries included in the sample, there have been several episodes of electoral reform that are likely to have lasted long enough to exert an impact on energy policy outcomes. Previous studies have leveraged this rare but important variation to examine the impact of electoral reform on policy outcomes of interest (Chang et al. 2008; Chang et al. 2010). By taking advantage of these changes, we can address the possibility that the cross-sectional results are biased by unchanging country-specific factors, such as culture, local climate conditions, or geography. Three countries in my dataset have undergone meaningful, sustained electoral change. Japan moved from a single nontransferable vote multi-member district system to a mixed-member majoritarian system in 1994. New Zealand moved in the reverse direction, from a Westminster-style majoritarian system to a mixed-member proportional system in 1993. Italy shifted from an open-list PR system to a mixed-member majoritarian system in 1993. Italy subsequently moved back to a PR

system in 2005.¹⁵ To capture over-time variation in electoral systems, I will focus on the dichotomous indicator of PR/majoritarian electoral systems. As discussed earlier, the Cox threshold is not suited to capture sharp shifts in electoral incentives associated with reform.¹⁶

Table 2 lists the four major episodes of electoral reform and the CO₂ emissions intensity of each country during the decade before and after electoral reform.¹⁷ As the table shows, the pace of emissions intensity reduction in Japan and Italy slowed down markedly after electoral reform in the direction of majoritarianism. In New Zealand and Italy's second reform, which moved these countries towards PR, we observe the opposite trend: New Zealand moved from rapidly increasing to declining emissions intensity, and Italy's pace of emissions reduction accelerated.

Importantly, the first wave of electoral reform among these three countries occurred in close succession in 1993-1994. This should give us some reassurance that the depicted trends do not reflect some unaccounted-for global factor, such as international climate change agreements or concerns about CO₂ emissions. Notably, the direction of change for Japan and Italy runs counter to increasing global concerns about climate change – both countries saw improvements in CO₂ emissions intensity stagnate during a period when concerns about climate change intensified, exemplified by the 1997 Kyoto Protocol.

¹⁵ France also underwent electoral reform, but its brief stint with proportional representation in 1986-1988 is unlikely to have had a meaningful impact on energy policy.

¹⁶ In the fixed effects specifications, substituting the Cox threshold for the dichotomous PR measure generally produces statistically insignificant and inconsistent results. This reflects several factors. First, even after electoral reform increases or decreases the viability of political parties or candidates, party consolidation or creation tends to occur slowly due to transaction costs and learning (Reed 1990). This means the measure does not immediately capture changes in electoral incentives associated with reform. Second, since electoral reform is generally implemented to redress perceived problems with the preexisting system, conditions immediately following reform are sometimes relatively extreme. For example, in Italy, where one motivation for reform was to reduce party fragmentation, the effective number of political parties peaked in 1994, and therefore the country is characterized by an extremely low Cox threshold immediately before and after reform. Third, the measure is associated with modest temporal variation across elections taking place within a single electoral system, as new parties are formed or disbanded. These fluctuations are unlikely to be associated with concurrent shifts in energy policy, but it is nonetheless captured in the empirical results.

¹⁷ The most recent nine years are used for Italy's second reform due to data availability.

Table 3 reports results from OLS model specifications with country fixed effects, in which a dichotomous indicator of PR is the key independent variable. Since there are more observations in this model, and I am considering over-time variation, I include several additional control variables. GDP and its square are included, as energy intensity is oftentimes assumed to follow an environmental Kuznet's curve (Grossman and Krueger 1995; Bättig and Bernauer 2009), with intensity rising with industrialization and falling with the growth of the service sector. I also include several additional climate-related variables, transport sector share of GDP, and trade openness, which were included separately in the cross-sectional models. The empirical results are robust to excluding these control variables across specifications. As the table shows, PR is associated with higher gasoline prices, higher electricity prices, lower energy intensity of the economy, and lower CO₂ intensity of the economy.¹⁸ Table 4 reports analogous results for transportation outcomes. Again, the findings are consistent with the theory: PR is associated with higher bus/rail share, less travel, less energy-intensive automobile travel, and less travel energy per GDP.

¹⁸ For the panel analysis, the price measures are adjusted for inflation to remove nominal price changes unrelated to energy policies.

Table 2: Electoral Reform and Change in CO₂ Intensity (kg per 2005 PPP US\$)

Country and Year/Type of Electoral Reform	Change in CO ₂ Intensity, 10 Years Before Electoral Reform	Change in CO ₂ Intensity, 10 Years After Electoral Reform	Difference in Change, Majoritarian - PR
Japan (1994) PR → Majoritarian	-13.5%	-3.1%	10.4%
Italy (1993) PR → Majoritarian	-10.0%	-0.0%	10.0%
New Zealand (1993) Majoritarian → PR	9.7%	-2.9%	12.6%
Italy (2005) Majoritarian → PR	-0.0%	-22.2% (9 years)	22.2%

Note: CO₂ intensity is a measure of how much CO₂ a country emits per unit of economic output produced. Lower CO₂ intensity implies that a country is able to emit less CO₂ for a comparable level of economic activity. The table shows that countries that changed their electoral systems saw greater reductions in CO₂ intensity under PR compared to majoritarian electoral systems.

Table 3: Electoral Rules and Energy Prices & Overall Energy Intensity, OLS with Fixed Effects

Indep Vars/ Dep Vars	Gasoline Prices (PPP US \$ / L)	Electricity Prices (PPP US \$ / Kwh)	Energy Intensity (kg of oil equivalent / GDP in \$US 2005 PPP)	CO ₂ Emissions Intensity (kg / GDP in \$US 2005 PPP)
Proportional Representation	0.20* (0.09)	0.011* (0.004)	-0.008* (0.003)	-0.03* (0.01)
Population Density	-13.53 (2.86)	-1.42* (0.18)	0.34 (0.19)	-0.67 (0.63)
GDP/Capita	-4.76* (0.44)	0.003 (0.027)	0.00 (0.03)	-0.30* (0.10)
GDP/Capita ²	-0.80* (0.11)	-0.003 (0.006)	-0.01 (0.01)	0.04 (0.02)
Manufacturing Share of GDP	2.62* (0.94)	0.03 (0.05)	0.03 (0.05)	0.36* (0.16)
Transportation Share of GDP	-7.36* (3.59)	-0.11 (0.23)	0.53* (0.22)	-0.21 (0.90)
Oil Production	-0.12* (0.03)	0.002 (0.001)	0.001 (0.001)	0.01 (0.01)
Trade Openness	0.00 (0.06)	0.003 (0.003)	0.000 (0.003)	-0.01 (0.01)
Constant	8.18* (0.87)	0.374* (0.046)	0.18* (0.05)	0.85* (0.16)
n	324	257	258	250

Note: All models are linear regressions with country fixed effects. Control variables included in the model but omitted from presentation: annual mean temperature, annual precipitation, and cloud cover. Gasoline and electricity prices are adjusted for inflation. Numbers in parenthesis are standard errors. Star denotes a coefficient at least two standard errors removed from zero.

Table 4: Electoral Rules and Transport Outcomes, OLS with Fixed Effects

Indep Vars/ Dep Vars	Rail & Bus Share of Total Travel (% of Passenger kilometers)	Total Distance Traveled (1000 kilometers per capita, annual)	Automobile Energy Intensity (MJ/Vehicle km)	Transportation Energy per GDP (PJ/billions of \$US 1990 PPP)
Proportional Representation	0.03* (0.01)	-0.44* (0.14)	-0.33* (0.06)	-0.10* (0.02)
Population Density	-0.72* (0.18)	-24.00* (4.69)	8.21* (1.69)	5.42* (0.94)
GDP/Capita	-0.26* (0.03)	10.26* (0.70)	1.93* (0.26)	1.18* (0.12)
GDP/Capita ²	0.05* (0.01)	-1.37* (0.18)	-0.63* (0.06)	-0.36* (0.03)
Manufacturing Share of GDP	-0.01 (0.06)	-13.54* (1.45)	2.08* (0.52)	-1.05* (0.25)
Transportation Share of GDP	0.51 (0.20)	-17.60* (5.30)	-0.41 (1.94)	-0.21 (0.90)
Oil Production	0.01* (0.00)	0.11* (0.04)	-0.09* (0.01)	-0.01 (0.01)
Trade Openness	0.00 (0.01)	-0.16 (0.09)	0.04 (0.03)	0.01 (0.02)
Constant	0.38* (0.08)	4.12* (1.30)	1.71* (0.47)	-0.03 (0.22)
n	352	352	338	339

Note: All models are linear regressions with country fixed effects. Control variables included in the model but omitted from presentation: annual mean temperature, annual precipitation, and cloud cover. Numbers in parenthesis are standard errors. Star denotes a coefficient at least two standard errors removed from zero.

Alternative Explanations

In Supporting Information III, I consider several potential alternative explanations for the association between electoral institutions and energy policy outcomes. None of these are mutually exclusive with my propositions, but it is useful to rule out the possibility that alternative explanations fully account for the findings presented above: First, variation in citizen preferences rather political institutions may account for variations in energy policy. Second, PR governments may be associated with provision of better infrastructure, which may also contribute to lower energy intensity. Third, PR electoral institutions may be associated with left-leaning governments or green parties that are more enthusiastic about pro-environmental policies, including higher prices on energy consumption. Fourth, the findings above may be subsumed by price differences across electoral systems attributable to the balance of producer-consumer power. I show that all of these alternative explanations have important shortcomings and are unable to account for at least some aspects of the empirical evidence presented above.

Electoral Reform and Energy Policy in Japan

In the Supporting Information IV, I include a detailed, qualitative case study of the evolution of energy policy in Japan before and after electoral reform in 1994. The case study demonstrates how the multimember district single nontransferable vote (MMD-SNTV) system, which was associated with a low Cox threshold, enabled Japanese policymakers to pursue energy conservation by imposing high costs for energy-intensive consumption and redistributing benefits to concentrated interest groups. In particular, various fuel taxes, automobile taxes, and highway tolls were levied to facilitate energy conservation after the 1973 oil shock, and the

revenues raised from these measures were redistributed directly to concentrated supporters of the ruling Liberal Democratic Party. After electoral reform, which introduced a mixed-member system dominated by single member districts, these energy conservation policies became politically unsustainable, leading to stagnation and rollback of major Japanese energy conservation policies. The case study provides strong support for the causal mechanisms associated with my theory.

In order to more rigorously examine the trajectory of energy policy in Japan after electoral reform, I use the synthetic control method (Abadie et al. 2010). Synthetic control seeks to overcome some of the problems associated with comparative case studies through data-driven construction of a control case that closely resembles the treated case of interest. In this case, synthetic Japan represents the weighted average of potential control countries, with weights chosen to closely reproduce the values of a set of predictors of CO₂ emissions intensity prior to electoral reform (1980-1993). The control countries are 24 high-income OECD states.¹⁹ The predictor variables are those used in the fixed effects analysis conducted earlier, namely population density, GDP per capita and its square, annual mean temperature, rainfall, cloud cover, manufacturing share of GDP, transportation share of GDP, along with CO₂ emissions intensity in 1980, 1985, and 1993.²⁰

The result is depicted in Figure 5. As the figure shows, CO₂ emissions intensity for Japan and synthetic Japan closely resemble one another until the mid-1990s, at which point a wide gap opens up. As predicted, after electoral reform, Japan emitted more CO₂ for each unit of economic output than implied by the synthetic control. In Supporting Information V, I provide additional details and show that the result is robust to a wide range of placebo tests.

¹⁹ Former communist states are excluded from the analysis, as they are not plausibly comparable to Japan during the pre-treatment period.

²⁰ See discussion in Abadie et al. (2011) about including prior values of the dependent variable.

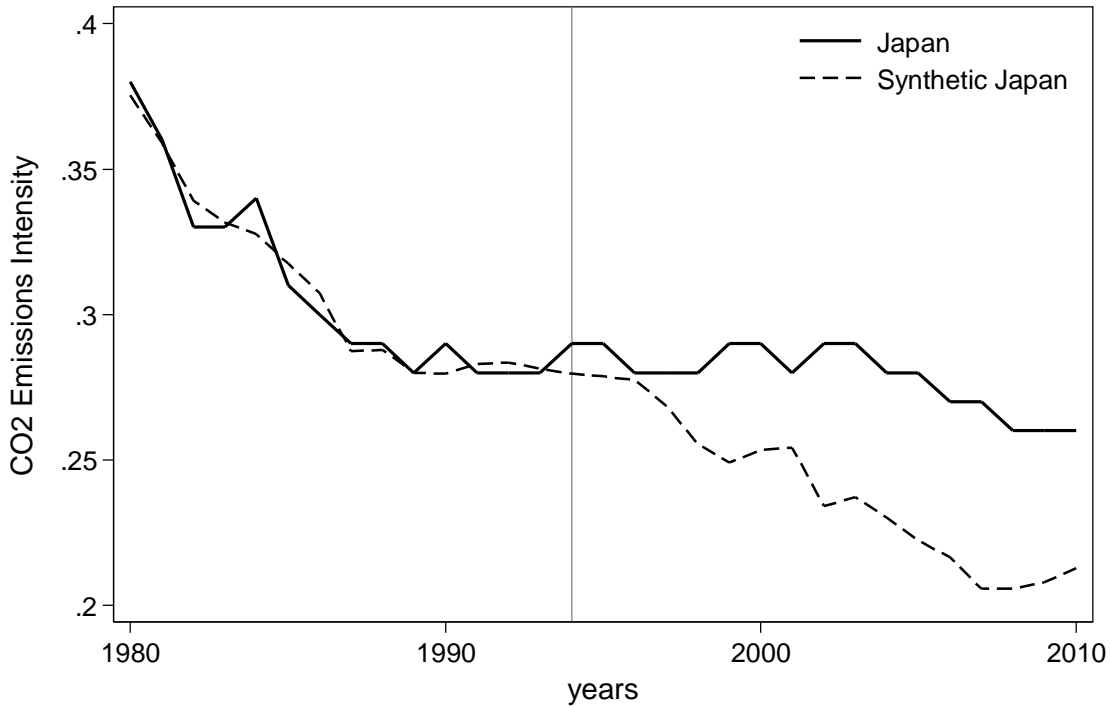
The slowdown of Japan's CO₂ emissions reductions primarily reflects stagnation in Japanese policies to promote energy conservation while other advanced industrialized countries implemented policies to address climate change. In recent years, many European countries have responded to climate change concerns by implementing a variety of measures to raise the price of energy consumption. These include routine increases in energy taxes and levies, but also major legislative initiatives. For example, Switzerland, which is weighted heavily in synthetic Japan, implemented the CO₂ Act in 1999, which included a CO₂ levy on various fuels and an emissions trading system (Bernard et al. 2005). Similarly, as part of its Ecological Tax Reform (ETR), Germany implemented a gasoline tax hike of 10 cents per year between 1999 and 2003. In comparison, Japan's gasoline tax rate has not been raised since electoral reform and has fallen from about 80% of the OECD average in 1980 to about 60-70% in the period after 1994.²¹ Similarly, Japanese electricity prices have fallen from about 2.1 times the OECD average in 1993 to 1.4 times in 2015.²² In this context, Japanese energy intensity and CO₂ emissions intensity stagnated, making it difficult for the country to meet its international emissions commitment under the Kyoto Protocol. This directly contributed to the country's decision to withdraw from the second commitment period of the agreement.²³

²¹ Calculated based on prices for regular unleaded gasoline (US\$/Litre in PPP). Data from the International Energy Agency, *IEA Energy Prices and Taxes Statistics*.

²² I provide a more extensive analysis of electricity prices in Japan elsewhere (AUTHOR). Data from the International Energy Agency, *IEA Energy Prices and Taxes Statistics*.

²³ Personal interview, Official of the Climate Change Division, Japan Ministry of Foreign Affairs, 6-7-2011.

Figure 5: Trends in CO₂ Emissions Intensity: Japan vs. Synthetic Japan



Note: CO₂ emissions intensity declined more rapidly for synthetic Japan compared to the actual trajectory for Japan after electoral reform in 1994. More details about the method and robustness checks are provided in the supporting information.

Conclusion

In this article, I have argued that electoral incentives play an important role in facilitating or obstructing energy conservation and the mitigation of greenhouse gas emissions. In particular, electoral systems that encourage narrow targeting are more effective at achieving energy conservation than systems that incentivize broad, popular appeal. I presented a wealth of empirical evidence in support of this theory, utilizing a new dataset on disaggregated energy consumption that includes eight different dependent variables. A detailed examination of

Japan's electoral reform illustrates how electoral reform weakened the foundations of Japan's traditional energy conservation policies.

The findings in this paper also introduce some previously unrecognized welfare implications. Extending the work of Rogowski and Kayser (2002), Chang et al (2010) argue that higher real prices associated with proportional representation systems impose a deadweight loss on society (Chapter 2). Importantly, this is not true where higher costs remedy an environmental externality, as is the case with high prices on energy consumption. In the presence of externalities, majoritarian systems may suffer from a tendency to *underprice* consumer goods compared to socially optimal levels. Hence, we may need to reassess previous research on cross-national price variation by disaggregating prices associated with externalities, particularly energy costs.

Can my theory be usefully applied to autocratic regimes? Like elected leaders that can return to office by securing support from narrow, organized interests, autocrats stay in power through the support of a narrow selectorate (Bueno de Mesquita et al. 1999; Bueno de mesquita et al. 2005). This suggests that autocratic regimes should also be relatively able to facilitate energy conservation and greenhouse gas mitigation by imposing diffuse costs on energy use. However, compared to OECD countries, where the impetus for energy conservation derives from both energy security and environmental motives, autocratic leaders appear to be generally less motivated by environmental concerns (Bättig and Bernauer 2009). This limits the direct applicability of my theory to autocratic states, but it may provide some grounds for optimism in political contexts such as China, where energy security and, more recently, severe environmental degradation has provided an impetus for energy conservation policies.

What implications do these findings have for global climate change efforts? To state the obvious, countries are unlikely to modify their electoral systems as a means to combat climate change. What this research does suggest is that international cooperation will encounter particular difficulty when dealing with countries with electoral rules emphasizing broad, popular appeal – e.g., majoritarian systems. In such countries, traditional solutions based on top-down international commitments are unlikely to prove effective. If global climate change is to be effectively addressed, it will be important to move beyond international commitments and devise mechanisms to address domestic political roadblocks to implementation.

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Supporting Information I: Supplemental Regression Tables

Table 5: Cox Threshold and Energy Prices & Overall Energy Intensity, 1990 OLS

Indep Vars/ Dep Vars	Gasoline Price (PPP US \$ / L)	Electricity Prices (PPP US \$ / Kwh)	Energy Intensity (kg of oil equivalent / GDP in \$US 2005 PPP)	CO ₂ Emissions Intensity (kg / GDP in \$US 2005 PPP)
Cox Threshold	-1.52 (0.71)	-0.21 (0.10)	0.32* (0.11)	1.09* (0.36)
Population Density	0.05 (0.32)	0.08 (0.10)	0.01 (0.07)	0.15 (0.21)
GDP/Capita	0.08 (0.12)	0.03 (0.01)	0.01 (0.02)	0.02 (0.05)
Annual Mean Temperature	0.01 (0.01)	0.003* (0.001)	-0.01* (0.00)	-0.00 (0.01)
Manufacturing Share of GDP	-1.02 (1.03)	-0.04 (0.28)	-0.12 (0.20)	0.73 (0.73)
Oil Production	0.01 (0.01)	0.002 (0.002)	-0.001 (0.002)	-0.00 (0.01)
Constant	0.75 (0.35)	0.05 (0.07)	0.17 (0.10)	-0.13 (0.29)
R ²	0.58	0.78	0.47	0.46
n	14	14	20	20

Note: All models are linear regressions with robust standard errors. Numbers in parenthesis are standard errors. Star denotes a coefficient at least two standard errors removed from zero.

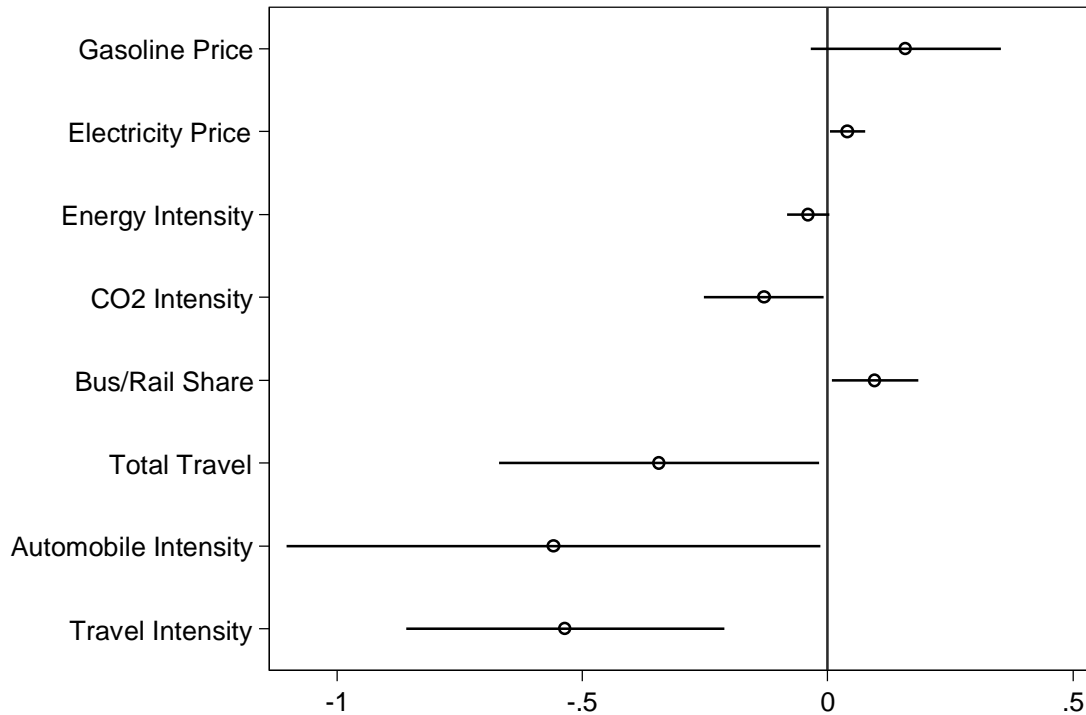
Table 6: Cox Threshold and Transportation Sector Outcomes, 1990 OLS

Indep Vars/ Dep Vars	Rail & Bus Share of Total Travel (% of Passenger kilometers)	Total Distance Traveled (10000 kilometers per capita, annual)	Automobile Energy Intensity (MJ/Vehicle km)	Transportation Energy per GDP (PJ/billions of \$US 1990 PPP)
Cox Threshold	-0.55* (0.23)	1.36* (0.51)	3.17* (1.22)	3.46* (0.43)
Population Density	0.06 (0.24)	-0.80* (0.24)	-0.95 (0.79)	-0.44 (0.27)
GDP/Capita	0.04 (0.04)	0.22 (0.16)	0.25 (0.30)	-0.26* (0.10)
Annual Mean Temperature	0.01 (0.00)	-0.01 (0.01)	0.01 (0.02)	-0.02 (0.01)
Manufacturing Share of GDP	0.46 (0.89)	-1.71 (0.95)	4.60 (2.95)	-0.56 (0.70)
Oil Production	-0.004 (0.005)	0.01 (0.02)	0.01 (0.03)	-0.01 (0.02)
Constant	0.10 (0.25)	1.02* (0.37)	0.50 (0.85)	0.94* (0.23)
R ²	0.56	0.82	0.72	0.93
n	14	14	14	14

Note: All models are linear regressions with robust standard errors. Numbers in parenthesis are standard errors. Star denotes a coefficient at least two standard errors removed from zero.

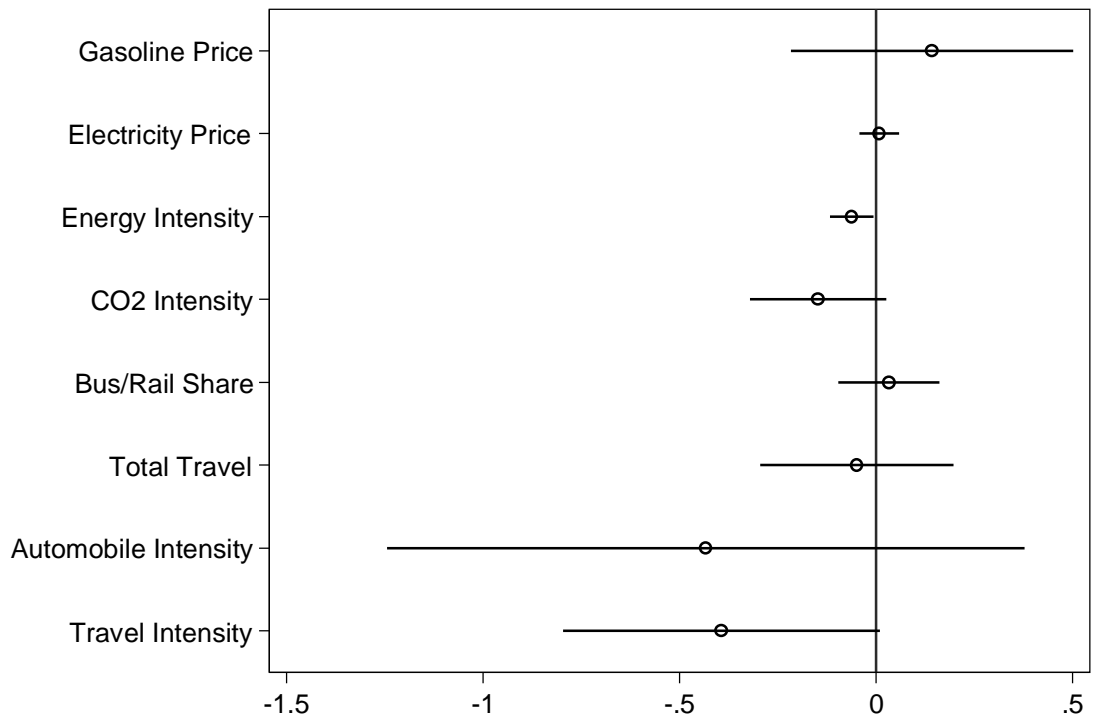
Supporting Information II: Cross-Sectional Analysis with PR as the Independent Variable

Figure 6: PR and Energy Policy Outcomes, 1990 (Excluding Control Variables)



Note: With control variables excluded, the PR dummy is associated with all energy policy outcomes in the expected direction. The dots represent coefficients, and lines 95% confidence intervals, from OLS model specifications where a dichotomous indicator for PR is the key independent variable and the dependent variable is listed vertically. The models presented in the figure are estimated with robust standards errors but omit the control variables.

Figure 7: PR and Energy Policy Outcomes, 1990 (Including Control Variables)



Note: When control variables are included, the PR models are estimated with less precision, but the coefficients retain the correct signs. The dots represent coefficients, and lines 95% confidence intervals, from OLS model specifications where a dichotomous indicator for PR is the key independent variable and the dependent variable is listed vertically. Each model is estimated with robust standard errors and includes the following control variables: population density, GDP/capita, annual mean temperature, manufacturing share of GDP, log of oil production.

Supporting Information III: Consideration of Alternative Explanations

Table 7: Distinguishing Variables

Alternative Theory	Distinguishing Variables	Comments
Preferences	Survey Responses of Citizens	If PR systems have citizens who are more supportive of price incentives to promote environmental causes, this should be apparent in public surveys. To be a confounder, preferences must also be associated with energy policy outcomes.
Infrastructure	Travel Distance per Capita	If PR systems tend to have superior infrastructure, we should observe greater travel distances per capita. My theory predicts lower travel distances due to higher costs of transportation.
Green Governments	Renewable Share of Electricity Production; Industrial Energy Intensity	If PR systems produce pro-environmental governments, we should observe measures to increase renewable energy and reduce industrial energy intensity. My proposed theory does not predict a strong association between electoral systems and these variables.
Producer-Consumer Power	Prices Pre- & Post- Oil Shocks; Energy Prices vs. Non-Energy Prices	If PR systems are generally associated with greater producer power, we should observe higher prices across the board. My theory predicts higher prices will be limited to energy-intensive consumption and the post-oil shocks period.

The evidence presented in the empirical sections of this article clearly demonstrates an association between electoral institutions on the one hand and energy policies and outcomes on the other. A wealth of cross-national and over-time evidence strongly suggests that this association is not spurious. In this section, I will address an important residual concern: even if an association between electoral institutions and energy outcomes exists, it may be due to causal mechanisms outside of my proposed theory. In particular, I will examine four plausible alternative explanations. First, variation in energy outcomes may be attributable to variation in citizen preferences over environmental policy. Second, electoral institutions may influence energy outcomes by producing variation in the quality of infrastructure. Third, some electoral institutions may be more prone to produce “green” governments that take aggressive measures to address environmental concerns. Fourth, electoral systems may simply produce variation in general prices, including prices for energy, which in turn affects energy outcomes. I will derive observable implications from each of these alternative explanations and compare the predictions to those derived from my theory.

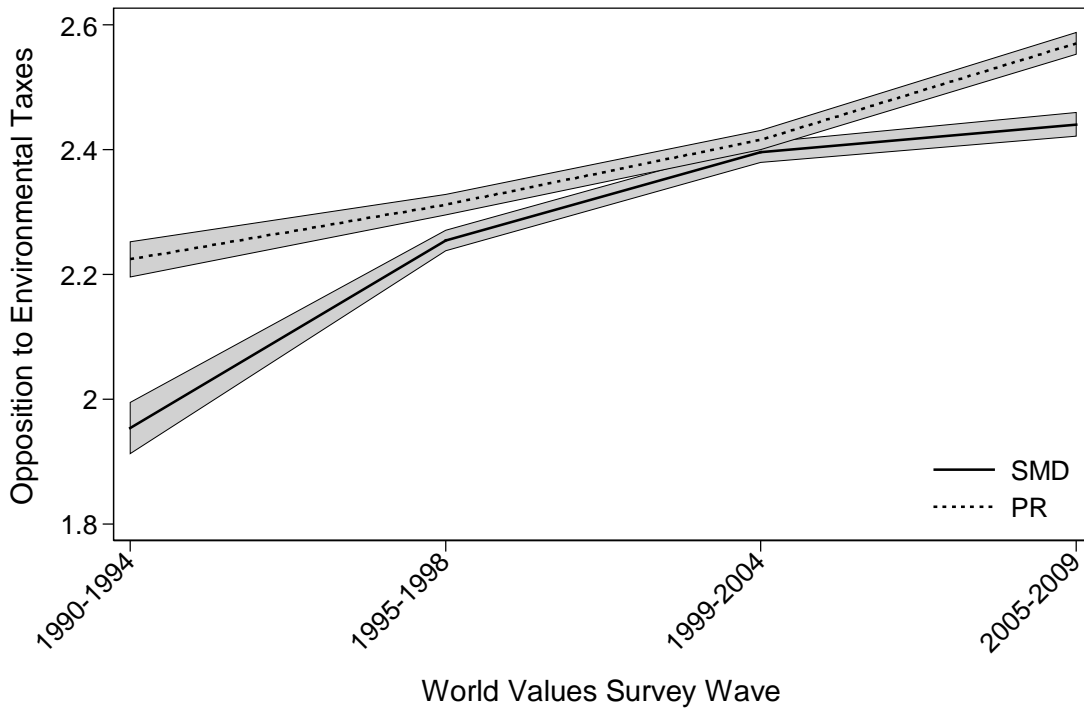
Preferences

One obvious alternative explanation for cross-national and cross-temporal variation in energy and environmental policies is the preferences of a country’s citizens. There is no strong *prima facie* basis to expect citizen preferences to be correlated with electoral institutions. However, the results presented in this article could be spurious if citizens living under PR systems are systematically more accepting of policies that raise prices for environmental purposes. To consider this possibility, I use data from the World Values Survey, which has

included several survey items on the willingness of citizens to accept financial sacrifices in order to protect the environment (World Values Survey 2015).

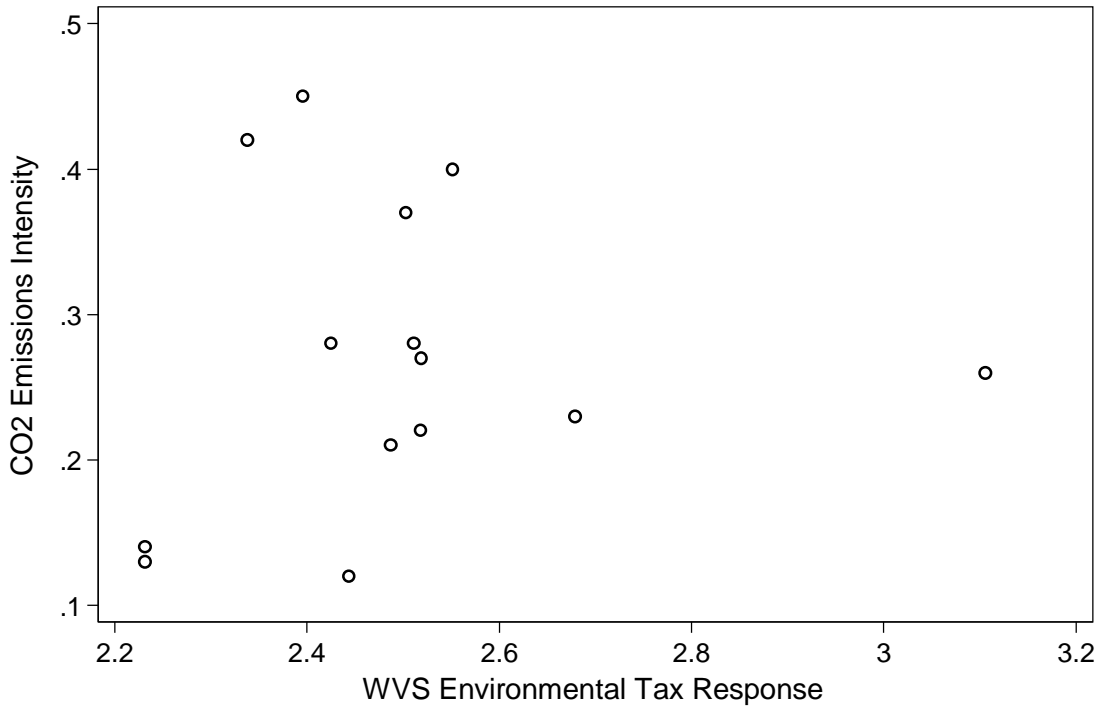
Figure 8 presents responses to the following survey item, which closely corresponds to the causal mechanisms examined in this article: “I am now going to read out some statements about the environment. For each one I read out, can you tell me whether you agree strongly, agree, disagree or disagree strongly?: I would agree to an increase in taxes if the extra money were used to prevent environmental damage,” where 1= Strongly Agree, 2=Agree, 3=Disagree, 4=Strongly Disagree; i.e., high numbers indicate opposition to environmental taxes. Survey respondents are separated by their country’s electoral system at the time the survey was administered. As the figure shows, there is no clear difference in responses to this question according to electoral system. In fact, citizens under PR governments are slightly more prone to oppose environmental taxes.

Figure 8: Opposition to Environmental Taxes by Electoral System, 1989-2009 (World Values Survey)



Note: Opposition to environmental taxes is not higher in SMD systems compared to PR systems. Based on survey item B002, “I am now going to read out some statements about the environment. For each one I read out, can you tell me whether you agree strongly, agree, disagree or disagree strongly?: I would agree to an increase in taxes if the extra money were used to prevent environmental damage,” where 1= Strongly Agree, 2=Agree, 3=Disagree, 4=Strongly Disagree.

Figure 9: Citizen Preferences and CO₂ Emissions Intensity by Country (2005)



Note: There is no relationship between citizen preferences about environmental taxes and cross-national variation in CO₂ emissions intensity. The y axis is CO₂ / GDP PPP (kgCO₂ per 2010 US dollar), and the x axis reflects mean responses to survey item B002, “I am now going to read out some statements about the environment. For each one I read out, can you tell me whether you agree strongly, agree, disagree or disagree strongly?: I would agree to an increase in taxes if the extra money were used to prevent environmental damage,” where 1= Strongly Agree, 2=Agree, 3=Disagree, 4=Strongly Disagree.

Although the WVS data does not cover a sufficient number of countries-years to be meaningfully used as a control variable in the main analysis of the article, the raw data suggests that citizen preferences are not strongly associated with the energy policy outcomes analyzed. For example, Figure 9 plots survey responses to the question about environmental taxes against CO₂ emissions intensity. As the figure shows, there is no relationship between citizen

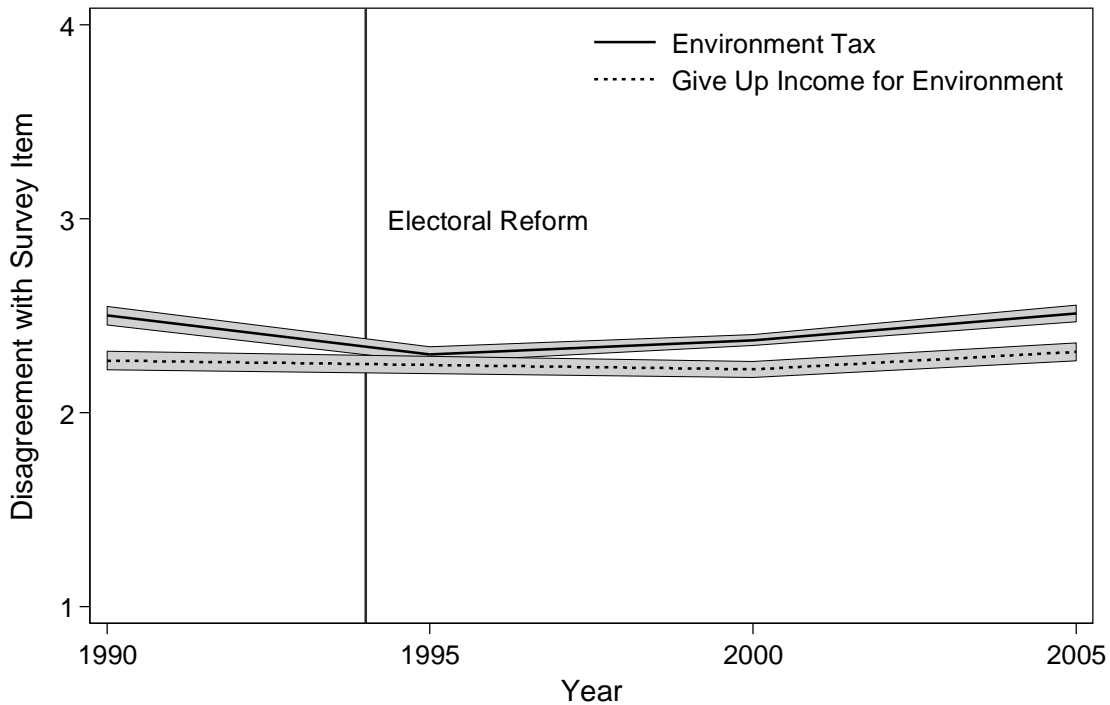
preferences expressed through this survey measure and CO₂ intensity ($r=0.10$). The same is true of the other energy policy outcome measures examined.²⁴

Responses to other questions examining the willingness of citizens to bear costs to protect the environment exhibit an analogous pattern. Mean responses to “Would give part of my income for the environment,” by electoral system were 2.21 for SMD countries and 2.36 for PR countries. Mean responses to “Would buy things at a 20% higher price if it helped to protect environment,” were 2.57 for SMD and 2.55 for PR countries.

Two of the survey items concerning willingness to sacrifice for environmental causes were administered before and after electoral reform in Japan, which allows us to examine if changes in energy in policy might be attributed to a change in the preferences of Japanese citizens (There are no relevant survey items that were administered on both sides of electoral reform for Italy and New Zealand). These are “Increase in taxes if used to prevent environmental pollution” and “Would give part of my income for the environment,” where high numbers indicate disagreement and low numbers indicate agreement. As Figure 10 shows, there is no noticeable shift in Japanese survey responses before and after electoral reform in 1994. The evolution of Japanese energy policy since the 1990s cannot be attributed to a shift in Japanese citizen preferences.

²⁴ The only possible exception is automobile fuel intensity, which is the only measure for which $r > 0.3$.

Figure 10: Opposition to Environmental Tax & Giving Up Income for the Environment, Japan 1990-2005, World Values Survey



Note: Opposition towards environmental taxes and giving up income for the environment was comparable before and after electoral reform in Japan. Based on survey item B002, “I am now going to read out some statements about the environment. For each one I read out, can you tell me whether you agree strongly, agree, disagree or disagree strongly?: I would agree to an increase in taxes if the extra money were used to prevent environmental damage” and B001 “...: I would give part of my income for the environment,” where 1= Strongly Agree, 2=Agree, 3=Disagree, 4=Strongly Disagree.

In sum, there is no basis to believe that variation in citizen preferences is responsible for the cross-national or temporal variation in energy policy outcomes analyzed in this article.

Although there is modest variation in citizen preferences cross-nationally, it is largely uncorrelated with both electoral systems and the energy policy outcomes examined in this article.

Infrastructure

It has been argued that PR systems tend to make greater investments in infrastructure due to the more secure tenure of politicians.²⁵ Better infrastructure could facilitate energy conservation through several channels. First, greater investments in public transportation infrastructure could shift users towards more energy efficient means of transportation, such as bus or rail. In addition, greater investments in road infrastructure, such as the provision of highways, more lanes, or rationalization, could contribute to greater realized automobile fuel economy by reducing traffic congestion. These factors would tend to reduce overall energy and CO₂ emissions intensity, which is consistent with the predictions of my theory.

However, the infrastructure explanation produces several observable implications that run counter to my theoretical predictions. If PR systems have superior transportation infrastructure, overall transportation *activity* should be higher, rather than lower. Better infrastructure enables users to travel longer distances with greater convenience, regardless of which particular mode they choose to use. As we already saw above, this is not the case: overall travel distances per capita in PR systems are relatively lower, not higher. In addition, *ceteris paribus*, better infrastructure will tend to produce lower energy prices as distribution costs fall, which is contrary to the empirical findings. Finally, the effect of better infrastructure on mode share is ambiguous – infrastructure improvements could be directed towards better roads or better rail transportation. Nonetheless, as we saw above, there is a very clear association between mode share and electoral institutions.

²⁵ See discussion in Chang et al 2010, pg. 231-233.

Green Governments

Another possibility worth considering is that the findings presented in this article could be explained by the tendency for PR to produce governments that are more environmentally friendly (Fredriksson and Millimet 2004). The lower effective thresholds for legislative representation under PR make it easier for single-issue parties to emerge and exercise political influence (Kitschelt 1989; Rohrschneider 1993; Burchell 2002; Folke 2014). Consequently, green parties have been generally more viable and influential in PR countries. In addition, governing coalitions in PR countries tend to lean center-left due to redistributive incentives (Iversen and Soskice 2006), and environmentalism is generally associated with left-leaning parties.

While there is likely some truth to this alternative explanation, it is unlikely to account for the findings presented in this article for several reasons. First, if the empirical findings described above are solely due to the left-leaning tendencies of PR governments, we would also expect to see progressive principles reflected in specific policy measures implemented in the energy sector. High prices for energy consumption, particularly on basic, daily necessities such as electricity and fuel, tend to harm relatively poor members of society. Without reference to my theory, it would be puzzling that, among the various means through which environmentalism might be pursued – e.g. regulatory policy, preservation of nature, waste management – left-leaning governments would opt for a particularly regressive means of achieving their objectives.

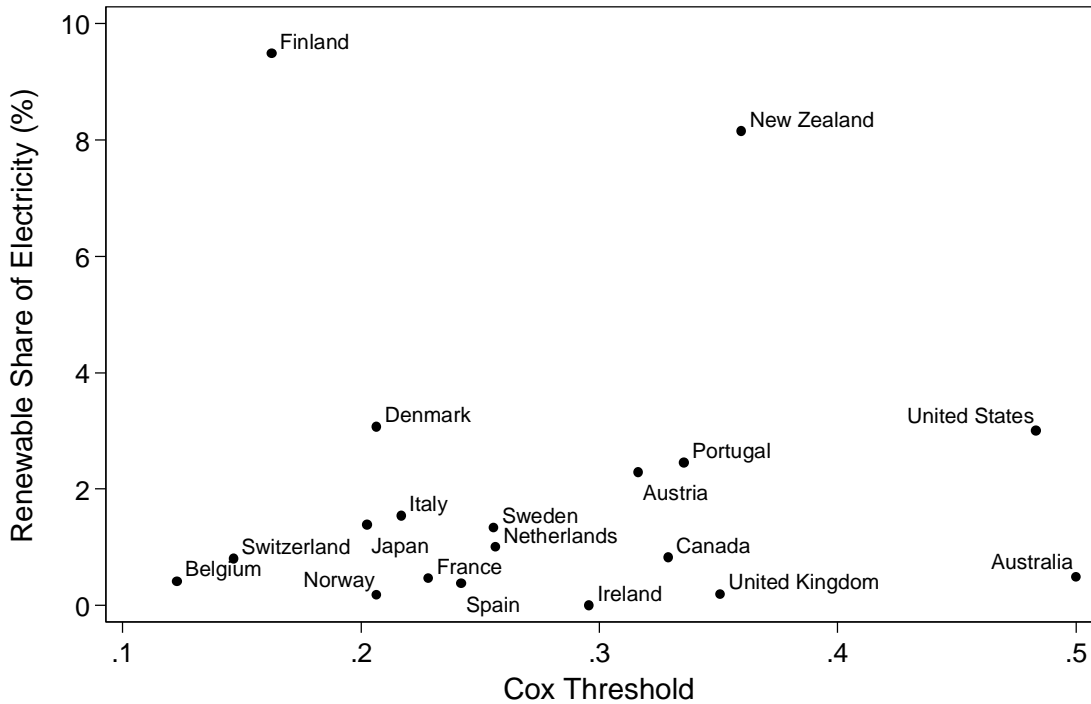
Second, as a related point, if we assume that environmentalism is the primary motivation of PR governments, we would expect aggressive pro-environmental measures across the board. One obvious area for policy intervention by such governments would be renewable energy from sources such as wind, solar, and geothermal energy, which are the cleanest and most

environmentally sustainable sources of electricity. However, the relationship between electoral institutions and adoption of renewable energy is weak. Figure 11 depicts the association between renewable share of electricity generation against the Cox Threshold in 1990, prior to major episodes of electoral reform.²⁶ The renewable measure excludes hydro power, which is generally not promoted by environmental groups due to its impact on local ecosystems and habitats (McCully 2001; Lowry 2003; Vaughn 2011). As the figure shows, there is essentially no relationship between renewable energy share and electoral institutions.²⁷ I also reran the empirical models from the previous section, using renewable share as the dependent variable: for both the cross-sectional and panel models, there is no meaningful association between renewable share and the electoral variables.

²⁶ The data comes from the World Bank, *World Development Indicators*, 2016.

²⁷ $r = 0.00$. Finland's high share is due to a significant contribution of black liquor and wood burning, and New Zealand geothermal energy.

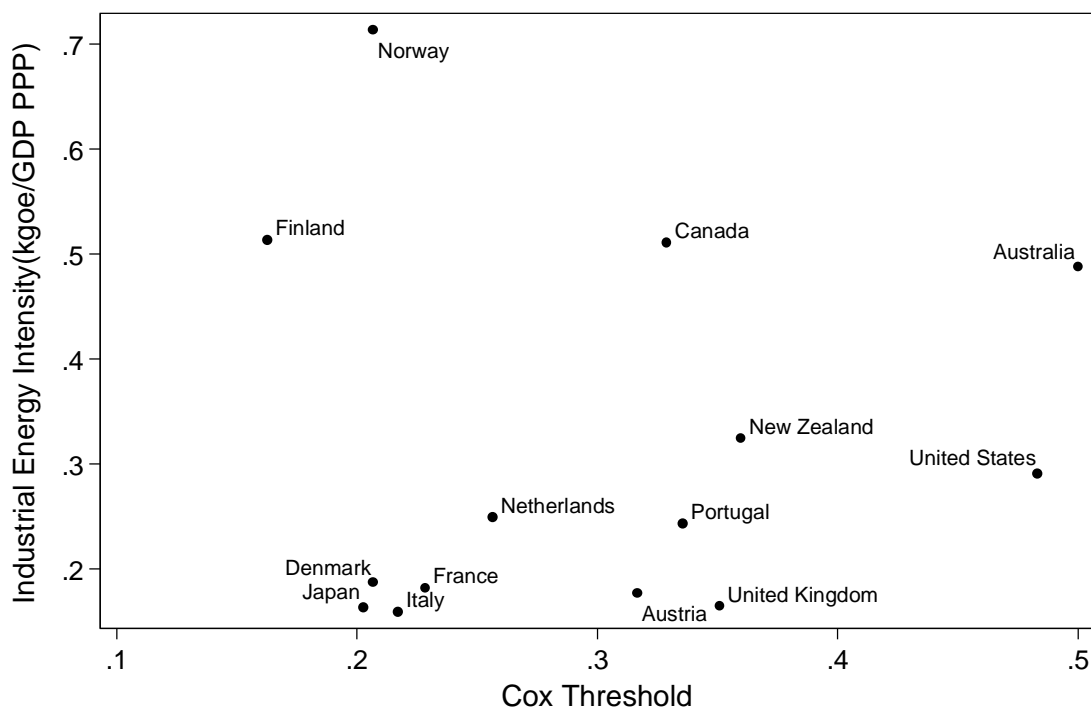
Figure 11: Renewable Share of Electricity Generation Excluding Hydro, 1990



Third, if the environmentalist explanation is correct, PR governments should seek to rein in energy consumption and emissions by all societal actors, including producer groups. Industrial energy consumption, while not as large as energy consumption in the rest of the economy, is still substantial, and is often the target of political activism by environmental groups. As such, we would expect environmentally conscious governments to implement aggressive policy measures vis-à-vis industrial energy consumption. In contrast, my theory predicts that the burden of energy conservation in PR systems will fall predominantly on consumers, who are less influential politically and unable to credibly threaten exit. Figure 12 depicts the relationship between the Cox Threshold and industrial energy intensity in 1990. As the figure illustrates,

there is no meaningful association between industrial energy intensity and the Cox threshold.²⁸ Several countries with very low Cox thresholds, namely Norway and Finland, also exhibit the highest industrial energy intensities. Environmental policy alone is clearly insufficient to account for the empirical findings presented in this chapter.

Figure 12: Industrial Energy Intensity, 1990



Producer-Consumer Power

As discussed earlier, a well-established and influential body of work argues that majoritarian systems tend to have lower overall price levels (Rogowski and Kayser 2002; Chang et al. 2010). Suppose, as this research suggests, that the balance of producer-consumer power is tilted towards consumers in majoritarian systems, and therefore consumers enjoy lower prices

²⁸ $r = 0.05$.

across the board. This also implies that consumers will enjoy low prices for energy consumption and energy-intensive consumption. This raises the possibility that the findings presented above are epiphenomenal to a broader producer-consumer power story.

The producer-consumer power account is not fundamentally at odds with the basic theoretical premises of this book, which posits that incentives generated by electoral systems affect the ability of governments to impose higher prices on consumers. However, the causal mechanism implied by each story is somewhat different. If the consumer-producer power account is correct, variation in energy policy outcomes ought to be seen largely as an externality of the interplay between consumers and producers. My account accords a greater role to government action, specifically attempts to encourage energy conservation by raising the costs of energy and energy-intensive consumption.

These are not necessarily competing explanations – it is entirely plausible that both mechanisms are at play. However, it is possible to test for two different observable implications associated with each causal mechanism. The producer-consumer power explanation is time- and product- invariant. Electoral systems should affect the balance of power between consumers and producers similarly across time periods and products. On the other hand, concerns about energy security and conservation spiked dramatically after the oil shocks of 1973 and 1979, when oil prices increased fivefold, motivating governments across the OECD to initiate various conservation programs. In more recent years, an additional impetus has been provided by concerns over global climate change. Prior to the 1970s, real oil prices had been falling consistently for about fifty years, energy was abundant, and energy conservation was not an important concern. Similarly, while the producer-consumer power story predicts a similar pattern of price differentials across product categories, my theory predicts particularly

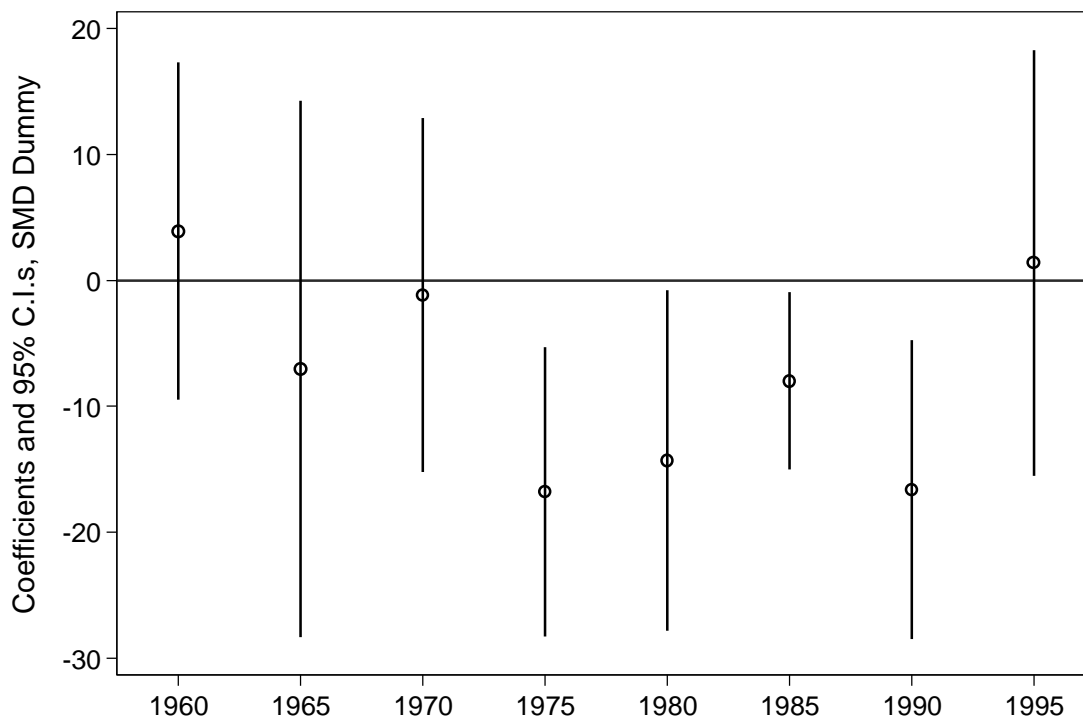
pronounced effects in prices that directly bear on energy conservation, such as prices for energy consumption and energy-intensive products.

I therefore examine empirically whether or not there was a change in the relationship between price levels and electoral systems after the 1970s oil shocks. The consumer-producer power story predicts a consistent relationship over time. My theory suggests that there ought to be a greater divergence in prices across electoral arrangements after the 1970s. To conduct this test, I replicate and extend the findings from Rogowski and Kayser (2002). The original analysis was performed on cross-sectional data from 1990. I rerun their empirical model for preceding years, specifically 1960, 1965, 1970, 1975, 1980, and 1985. I present results from model 1.3 of Table 1 in their paper, but similar substantive results were obtained from replications of other model specifications. Specifically, I use an OLS regression where the dependent variable is price levels across OECD countries, expressed as prices of aggregate GDP inclusive of tax. The key independent variable is a dichotomous indicator of single member district (SMD) electoral systems. Following the original analysis, I also include controls for per capita GDP, trade openness, and 3 year exchange rate appreciation.

Figure 13 presents the substantive results of interest. The dots represent coefficients for the SMD dummy from the OLS regressions, and the lines represent 95% confidence intervals. The original results from Kayser and Rogowski (2002) correspond to 1990 in the figure. Consistent with the original results, in 1990, there is a negative and statistically significant relationship between the SMD dummy and price levels – prices are lower in countries with SMD electoral systems. This relationship does not hold in 1995, but that can be explained by electoral reform in Italy, Japan and New Zealand, which took place in the early 1990s – the electoral systems of these countries shifted, but price levels did not adjust immediately. More importantly

for our purposes, the figure illustrates that the relationship between SMD electoral systems and low prices only emerged in the 1970s. Prior to the oil shocks, there is no statistically significant relationship between electoral systems and price levels.

Figure 13: Replication and Extension of Kayser and Rogowski (2002), Over Time



Note: The dots represent coefficients, and lines 95% confidence intervals, from model specifications where price levels are the dependent variable and a dichotomous indicator of single member district (SMD) electoral system is the key independent variable. The results show that SMD is associated with lower price levels only after the mid-1970s. The result for 1995 reflects countries that underwent electoral reform in the early 1990s.

Several additional points are worth noting. First, unlike the 1990s, there were no changes in electoral systems for the countries included in this analysis during the 1960s and 1970s.

Second, to guard against the possibility that the results are attributable to different countries represented in the sample, I ran the analysis including and excluding Greece, Portugal, and Spain,

which underwent democratic transitions and therefore appear in the dataset during only some time periods – the substantive results were the same (the figure excludes these countries). Third, the raw data tells the same basic story. For example, in 1990, price levels averaged across all SMD countries (104) were lower than those for non-SMD countries (136).²⁹ In contrast, in 1960, average price levels for SMD countries (84) were slightly higher than those for non-SMD countries (71). Fourth, I also replicated the panel results in Chang et al. (2010), which extended the original results in Kayser and Rogowski (2002) to the years 1970-2000. Extending the data to 1960-2000 weakened the relationship between electoral systems and price levels, and the relationship was no longer statistically significant across all model specifications.³⁰

Figure 14 similarly replicates the results from Kayser and Rogowski (2002) across product categories.³¹ The results indicate that price differentials across electoral arrangements are focused primarily in the consumption of energy-intensive products, such as transport and clothing. In contrast, there is no statistically significant difference between electoral systems in prices for less energy-intensive products such as health, communication, and education.

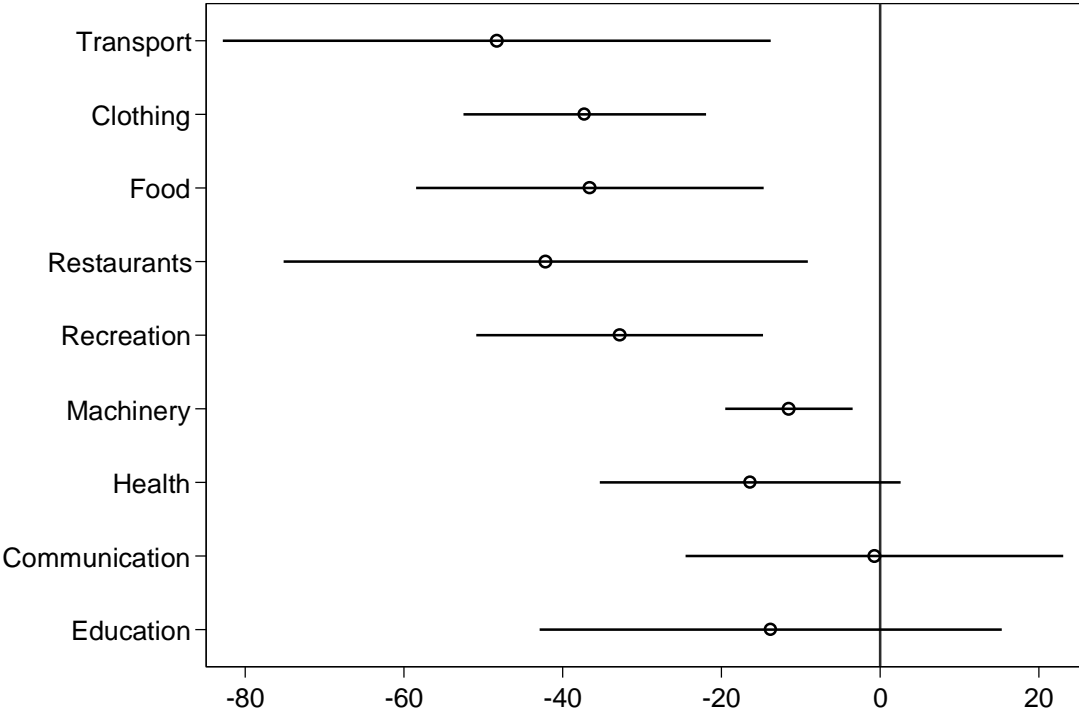
These results suggest that it is highly unlikely that the empirical results presented in this article are derivative of lower overall price levels in majoritarian systems. Price differentials across electoral systems are particularly pronounced in energy-intensive consumption, and there is relatively weak evidence of price differentials in non-energy-intensive sectors and in the 1960s, which is contrary to the expectations of producer-consumer power theory.

²⁹ Prices are expressed relative to the United States, with the United States normalized to 100, as in the original analysis.

³⁰ I replicated and extended the results for the PCSE, between-effects, and Arellano-Bond dynamic panel-data estimation models.

³¹ Data on individual product prices are from the International Comparison Program (ICP) of the World Bank, except gasoline and electricity prices, which are from the IEA, *Energy Prices and Taxes Statistics*. All data are for 2005 due to availability of ICP data. Since prices tend to change slowly, countries that underwent electoral reform in the 1990s are excluded from the analysis to focus on cases where electoral arrangements were held constant for an extended period of time.

Figure 14: Replication and Extension of Kayser and Rogowski (2002), by Product



Note: The dots represent coefficients, and lines 95% confidence intervals, from model specifications where price levels are the dependent variable and a dichotomous indicator of single member district (SMD) electoral system is the key independent variable. The results show that SMD is generally associated with lower price levels only for consumption of energy-intensive products. Results are for 2005 due to availability of the price data, and countries that underwent electoral reform in the 1990s are excluded from the analysis.

Supporting Information IV: Qualitative Case Study of Japanese Energy Policies

In this section, I will supplement the quantitative empirical results presented in the article by examining in greater depth a specific instance of electoral reform: that of Japan in 1994.³² For much of the period after World War II, Japan was governed by a single nontransferable vote multimember district (SNTV/MMD) electoral system that encouraged particularism over broad, public appeal, and consequent LDP one-party dominance (Rosenbluth 1989; Sakakibara 1991; Ramseyer and Rosenbluth 1993; McCubbins and Rosenbluth 1995; Scheiner 2006). Electoral reform in 1994 put in place a mixed system placing greater emphasis on plurality voting in single-member districts. This reform was designed to reduce particularism by giving politicians electoral incentives to appeal more broadly to the general electorate (Christensen 1994; Reed and Thies 2001). This has shifted the electoral strategy of politicians away from narrow targeting of interest groups – e.g. the construction and agricultural sectors – towards broad appeal to the median voter (Cox et al. 1999; Hirano 2006; Rosenbluth et al. 2010; Rosenbluth and Thies 2010). This shift in electoral incentives therefore provides an opportunity to examine the *prima facie* plausibility of the proposed theory.³³ I will focus in particular on Japanese policies in the transportation sector, which relate directly to my theoretical premises about diffuse energy consumption.

³² The other plausible case studies are Italy and New Zealand. I have examined the evolution of energy policy in Italy and New Zealand elsewhere, and the patterns are broadly consistent with the theoretical predictions. I focus on Japan for the in-depth case study here as 1) it offers a longer track record post-electoral reform compared to Italy, which reverted to PR in 2005; and 2) it is a much larger and modern economy compared to New Zealand, which has a somewhat quirky energy profile with a large share of emissions attributable to the agricultural sector.

³³ The account below is largely based on primary Japanese government documents and interviews of transportation policymakers and experts in Japan, specifically officials at the Ministry of Economy, Trade and Industry, the Ministry of Land, Infrastructure, Transport, and Tourism, the Institute of Energy Economics Japan, Japan Automobile Research Institute, and National Traffic Safety and Environment Laboratory.

The Electoral Politics of Energy in Japan

During much of the post-World War II period, Japanese transportation policy was utilized by the LDP as a principal mechanism to redistribute economic resources to its political supporters – in particular, the construction industry and rural residents. The philosophy was laid out most clearly by Prime Minister Tanaka Kakuei in his *Nihon Retto Kaizo Keikaku* (Japan Reforming Plan), which emphasized the construction of road and rail infrastructure to promote the economic development of rural areas (Tanaka 1972). However, Japan's infrastructure policies were also heavily influenced by the oil shocks of the 1970s and a national imperative to achieve energy efficiency and energy conservation. This imperative was articulated and promoted aggressively by Japan's elite bureaucracy, which has traditionally enjoyed considerable autonomy and agenda-setting power (Johnson 1982; Okimoto 1990).

The net result was a series of policies that exemplified the electoral logic of energy policy outlined in this article. Prices were raised aggressively on the general transportation consumer, particularly users of private automobiles. This suppressed overall travel and car use in particular, putting a cap on energy consumption in the transportation sector. The revenues raised from elevated prices were used to directly or indirectly subsidize core supporters of the LDP – the construction industry and rural residents (Lipsy and Schipper 2013). These policies were elegantly incentive-compatible with Japan's SNTV/MMD electoral system, in which the interests of the general consumer could be effectively marginalized as long as the narrow interests of core supporters were well served.

Although there were a host of specific policy measures adopted in Japan along these lines, I will focus on three which are likely to have had a particularly large substantive impact. The

first is highway tolls. When Japan completed its first highway, the *Meishin Expressway* in 1958, tolls were levied with the specific purpose of paying off the World Bank loan used towards its construction (Japan Automobile Manufacturers Association 2006). According to these initial plans, Japan's major highway routes, connecting the metropolitan areas of Tokyo, Nagoya, and Osaka, should have become free of tolls by the early 1990s. However, during the oil shocks of the 1970s, LDP Prime Minister Tanaka Kakuei implemented a policy of pooling highway tolls in order to support construction of infrastructure in rural areas (Sugimoto 2004). Instead of being eliminated, tolls on the main urban routes were repeatedly raised, imposing an onerous cost on long-distance automobile travel. For example, automobile travel from Tokyo to Osaka, about a 510km (315 mile) trip, costs 13,500 yen, or \$180.³⁴ The revenues from these profitable urban routes were used to subsidize road construction and maintenance in rural areas, benefiting two key constituents of the LDP – the construction industry and rural residents. The tolls on intra- and inter- urban highway routes make public transportation, particularly energy efficient rail travel, highly competitive.

The second policy measure is gasoline taxes. Gasoline taxes were raised in 1973 as a “temporary” measure to respond to the oil shock. Diet deliberations clearly indicate that the primary purpose of the tax was to raise revenues and encourage the conservation of gasoline (Ministry of Land Infrastructure Transport and Tourism (Japan) 2002). However, the tax proved far from temporary and was raised repeatedly in 1976, 1979, and 1993. All revenues from the temporary gasoline tax were earmarked for the Road Improvement Special Account, which benefited the construction industry and rural residents disproportionately by supporting expansion of the road network and maintenance.

³⁴ As of 2011, I assume weekday travel and a standard fare, which would have been typical in the earlier period before recent political developments to be discussed later in this section.

Finally, Japan has imposed a variety of hefty, direct taxes on automobile ownership. The *jidosha juryo zei*, or automobile weight tax, is exemplary. The tax was established in 1971 and raised sharply during the 1970s oil shocks. Although the precise calculation of the tax is complex, a standard compact car is generally assessed 45,000 yen (\$600) every three years, with heavier vehicles taxed at higher rates. Three fourths of the revenues from the automobile weight tax were assigned to the Road Improvement Special Account as was the case for gasoline taxes, but one fourth was designated directly for local governments in rural areas (*shichoson*) (Ministry of Land Infrastructure Transport and Tourism (Japan) 2002). Importantly, the weight tax is deeply discounted for *keijidosha*, or light-weight automobiles, which are owned at disproportionately high rates in rural areas.³⁵ A kei-car of comparable weight is taxed at about the quarter of the rate of regular automobiles. In effect, the automobile weight tax was designed to benefit core LDP supporters on both the revenue and spending side.

Energy Policy after Electoral Reform in Japan

The political arrangements that underpinned energy conservation in Japan were weakened by electoral reform in 1994. Under the new majoritarian rules, politicians could no longer return to office by appealing narrowly to a small subset of their constituents – electoral victory required broad, public appeal in single member districts. In turn, high transportation taxes were deeply unpopular among the general public, and entrepreneurial politicians targeted

³⁵ For example, kei-car ownership is only 23% in densely populated Tokyo, while it is 52% in sparsely populated Kochi. The correlation between population density and kei-car ownership by prefecture for the whole country is about -0.6. There are some practical reasons for this – rural households are likely to require two cars, and the second car is often a cheap kei-car. However, it is also an outcome encouraged by government policies – some benefits associated with kei-car ownership are only available for rural residents, e.g. free highway tolls, no need for registration of a parking spot.

these policies for elimination. Hence, despite rising concerns about global climate change and a spike in energy prices in the 2000s, Japan has been unable to respond by raising prices as it did during the oil shocks of the 1970s. Instead, highway tolls, gasoline taxes, and automobile taxation have all come under attack, and key policy debates have focused on whether these taxes should be eliminated or reduced.

Junichiro Koizumi, who governed Japan from 2001-2006, is widely recognized as having taken full advantage of Japan's new electoral system in his policymaking and electoral strategy (Reed et al. 2009). It is therefore unsurprising that Koizumi, despite being an LDP politician, targeted transportation policy as a critical area for his structural reform agenda. In particular, Koizumi sought to privatize Japan's major highway corporations and sever the link between road revenues and traditional redistributive politics. This produced considerable resistance from within LDP ranks, particularly from the *dorozoku* or "road tribe," who had long depended on these revenues to stay in office. Koizumi skillfully portrayed these members of his own party as *teikoseiryoku* (the forces of resistance), boosting his popularity with the general public. This strategy proved to be a resounding success under the new electoral system – in the 2005 lower house election, Koizumi won a lopsided victory, largely by framing the election as a referendum on his efforts to dismantle traditional LDP-style politics.

From the late 1990s, the Democratic Party of Japan gradually emerged as the LDP's counterpart in Japan's emerging two party system. Like Koizumi, the DPJ made transportation sector reform a core platform of its electoral strategy. It is instructive to consider Ichiro Ozawa, the DPJ president from 2006-2009, who is widely recognized as a "god of elections."³⁶ Ozawa personified the old model of pork barrel politics under the LDP, which he left in 1993. However,

³⁶ e.g., see "DPJ's 'God of Elections' faces fresh blow," *Financial Times*, 1-15-2010.

under the new electoral system, Ozawa became an outspoken advocate of eliminating transportation taxes.

In the 2000s, the DPJ advocated aggressively for a major reduction in automobile taxation and the elimination of highway tolls and the temporary gasoline tax. Because these policies imposed high costs on the general public, they are broadly unpopular – for example, the gasoline tax was opposed by 72% of the general public according to a 2008 *Kyodo* poll.³⁷ Similarly, 57% of survey respondents supported elimination or reduction of the automobile weight tax.³⁸ Under Japan’s new electoral calculus, targeting these unpopular policies for elimination is a tempting political strategy. In 2008, the DPJ leveraged its control over the upper house to force a temporary expiration of the temporary gasoline tax.³⁹

In anticipation of coming lower house elections, the LDP coopted several elements of the DPJ’s campaign platform, first eliminating the Road Improvement Special Account in 2008 and reducing highway tolls on weekends to a flat 1000 yen regardless of distance traveled. In its 2009 election manifesto, on the eve of taking over power, the DPJ stated that it would “Reduce the overall burden of automobile tonnage tax and automobile acquisition tax from the perspective of streamlining them and promoting environmentally friendly transportation,” and that, “Highway tolls will be gradually eliminated in principle, while keeping an eye on the effects of toll-less highways and the impact on other forms of public transportation.”⁴⁰

Once in power, the DPJ slashed the automobile weight tax by about 20% beginning in fiscal year 2010. After considerable internecine wrangling, the gasoline tax was effectively maintained at preexisting levels. In terms of highway tolls, several different plans were

³⁷ “Naikaku Shijiritsu 41%,” *Kyodo Tsushin Yoron Chosa*, 01-12-2008

³⁸ “Jidosha no Zeikin Ni Tsuite,” *JAMA Report* No. 91,

³⁹ E.g., Linda Seig, “Japan parliament set to clash over gasoline tax.” *Reuters*, January 28, 2008; Sachiko Sakamaki, “Fukuda Renews Japan Gas Tax, Facing Down Opposition.” *Bloomberg*, April 30, 2008.

⁴⁰ DPJ Manifesto, 2009

discussed, and MLIT experimented with a range of pricing plans on regional routes to evaluate the feasibility and effects of elimination. A plan to limit the maximum toll on weekdays to 2000 yen was slated to be implemented in April 2011.⁴¹ If implemented, this would have reduced the highway toll from Tokyo to Osaka by about 85%, sharply increasing the competitiveness of automobile transportation against rail. However, this plan was suspended after the Great Tohoku Earthquake of March 2011 in order to preserve revenues for reconstruction.

Figure 4 depicts the evolution of highway tolls, gasoline taxes, and the automobile weight tax in Japan, with 1970 levels normalized to 100.⁴² I also include CPI inflation as a reference. As the figure shows, these levies were raised rapidly in response to the 1970s oil shocks, with highway tolls in particular far exceeding the rate of inflation for two decades. The gasoline tax and automobile weight tax were raised sharply in the 1970s but then held relatively steady and declined in real terms through the 1980s. The gasoline tax was raised without much fanfare as recently as 1993. After electoral reform, none of these levies have been raised and all have been seriously considered for elimination or reduction.

Importantly, Japan's relative lack of responsiveness during the past two decades is not due to changing preferences or lack of interest in global climate change. Japan took an active role in facilitating the initial negotiations of the Kyoto Protocol (Tanabe 1999; Seki 2002; Hamanaka 2006; Oki 2007). Japanese bureaucrats still view energy efficiency as a top priority and frequently tout Japan's energy efficiency achievements to foreign observers. Despite its animosity towards transportation-related taxes, the DPJ sought to portray itself as an environmentally friendly party to appeal to its urban support base. Most notably, one of Prime

⁴¹“Kosoku Doro no Tomen no Aratana Ryokin Waribiki ni Tsuite,” MLIT Press Release, 2-16-2011.

⁴² Since the automobile weight tax was first implemented in 1971, it is normalized to 100 for that year. For highway tolls after 2009, I calculate average tolls based on ridership and average distance data from MLIT to account for the weekend fare discount. The gasoline tax data for 2008 is annualized accounting for the temporary suspension of the tax in April.

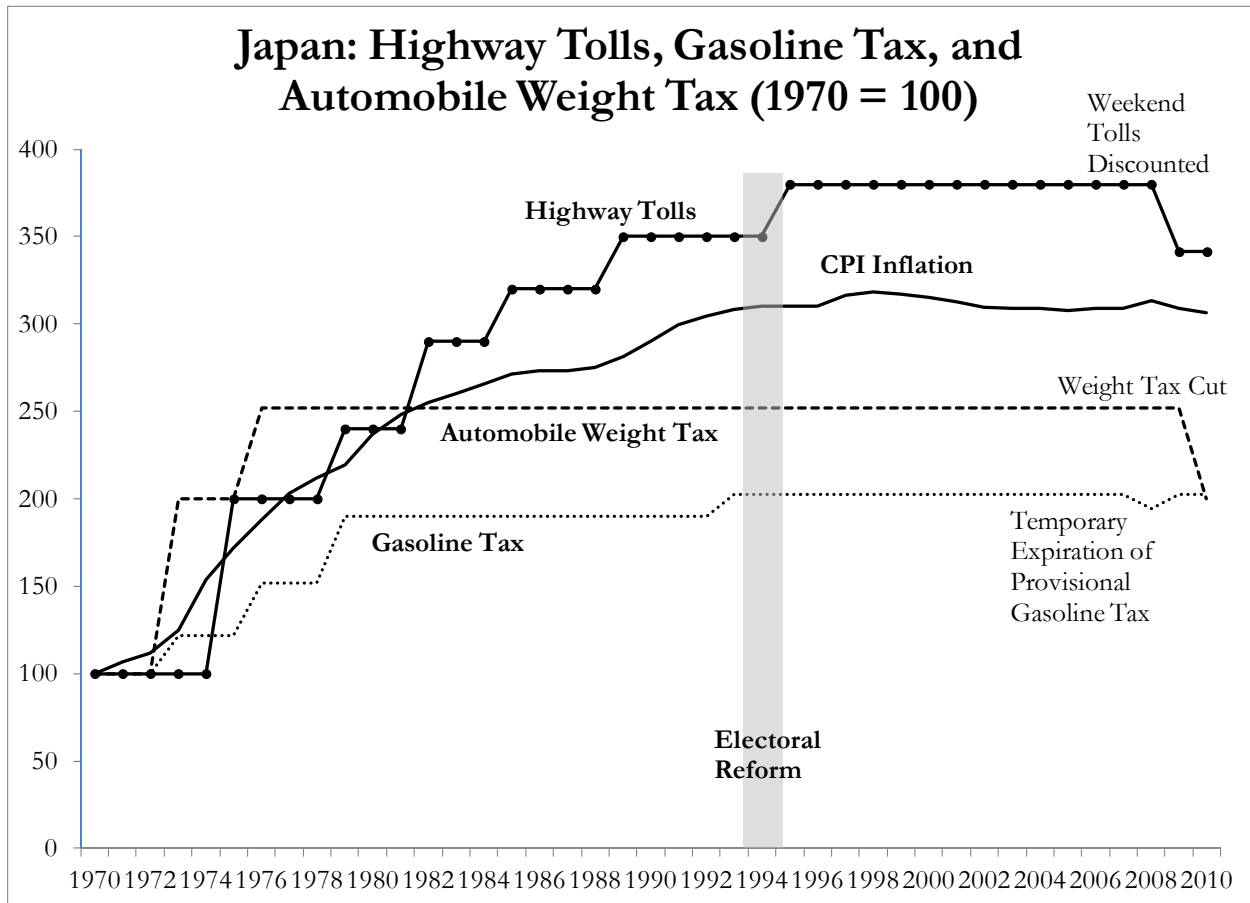
Minister Hatoyama's signature announcements upon taking office in 2009 was a 25% CO₂ emissions reduction target, which considerably exceeded prior LDP targets.

Polls in Japan generally indicate a high level of public concern regarding global warming and its potential consequences. A 2005 poll commissioned by the Ministry of Foreign Affairs found that 72% of Japanese survey respondents considered global warming a "global problem that is of serious concern to me in my daily life." Global warming received the highest affirmative response among the issues listed, which included environmental destruction (59%), terrorism and war (49%), infectious diseases (34%), international criminal activity (29%), and human rights abuses (28%).⁴³ 71% of survey respondents in a 2007 Cabinet Office poll indicated that they are responding to global warming *personally* by reducing their monthly consumption of electricity. Only 4% responded that they are doing nothing in their personal lives to respond to global warming.⁴⁴ In short, Japan is not falling behind because the public or policymakers have suddenly become environmental skeptics.

⁴³ Ministry of Foreign Affairs (Japan), "Chikyu Kankyo Mondai ni Kansuru Ishiki Chosa," 2005.

⁴⁴"Chikyu Ondanka Taisaku ni Kansuru Yoron Chosa," Cabinet Office, Government of Japan, 8-2007.

Figure 15: Japanese Automobile-related Taxes and Fees



Source: MLIT, Cabinet Office

Note: Japanese government fees and taxes related to automobiles were raised routinely prior to electoral reform in 1994, but not after electoral reform.

Supporting Information V: Supplemental Information on Synthetic Matching

Table 8: Synthetic Control Weights for Japan

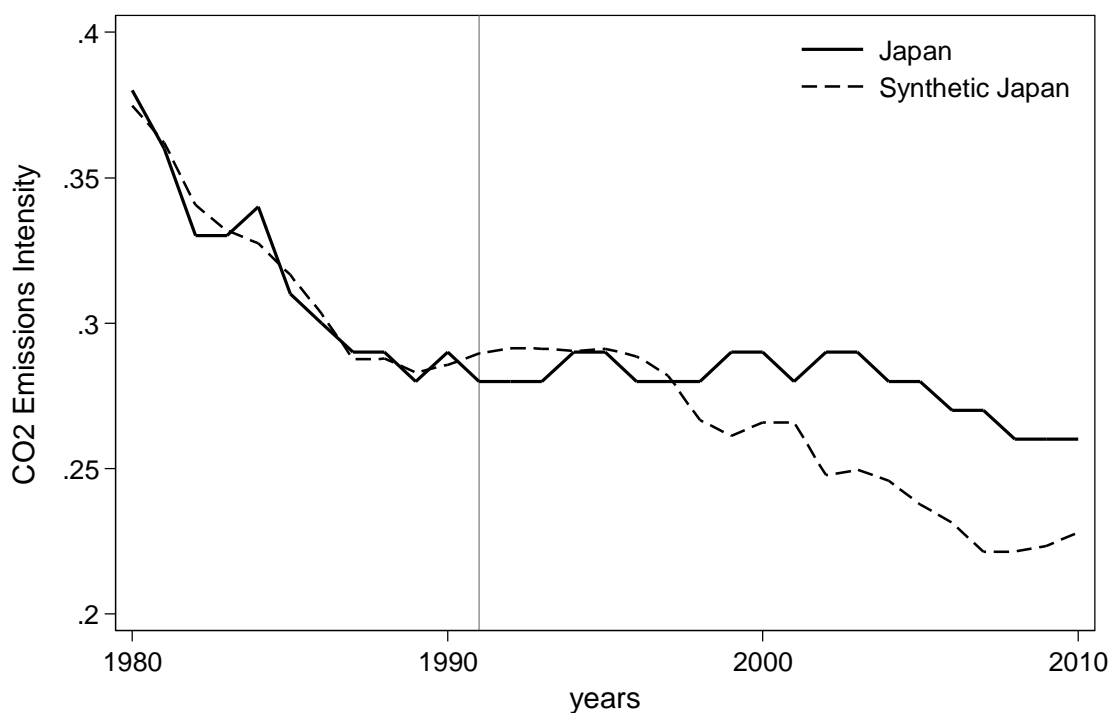
COW Country Code	Country Name	Synthetic Control Weight
2	United States	0.033
20	Canada	0
155	Chile	0
200	United Kingdom	0
205	Ireland	0
210	Netherlands	0
211	Belgium	0
220	France	0
225	Switzerland	0.449
230	Spain	0
235	Portugal	0
255	Germany	0.095
305	Austria	0
325	Italy	0
350	Greece	0
375	Finland	0
380	Sweden	0
385	Norway	0.107
390	Denmark	0
395	Iceland	0
666	Israel	0
732	South Korea	0.316
900	Australia	0
920	New Zealand	0

Table 9: Predictor Means Before Japanese Electoral Reform

Variable	Japan	Synthetic Japan
CO ₂ Emissions Intensity (1993)	0.28	0.28
CO ₂ Emissions Intensity (1985)	0.31	0.32
CO ₂ Emissions Intensity (1980)	0.38	0.38
Population Density	0.33	0.26
GDP/Capita	1.86	1.67
GDP/Capita ²	4.21	4.06
Mean Temperature	11.2	8.15
Rainfall	1.70	1.37
Cloud Cover	69.54	63.69
Manufacturing % of GDP	0.30	0.27
Transportation % of GDP	0.06	0.07

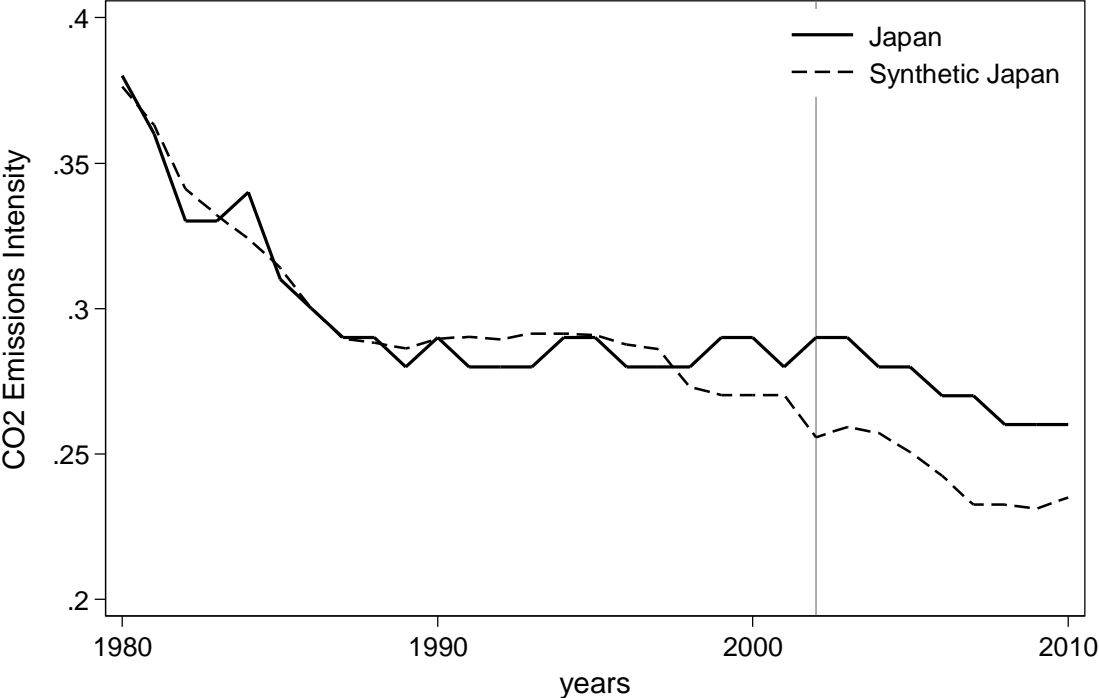
Note: the predictor variables for Japan and synthetic Japan are very similar; the only modest exceptions are the variables associated with climate conditions.

Figure 16: Placebo Test: Treatment in 1991 (Bursting of Asset Price Bubbles)



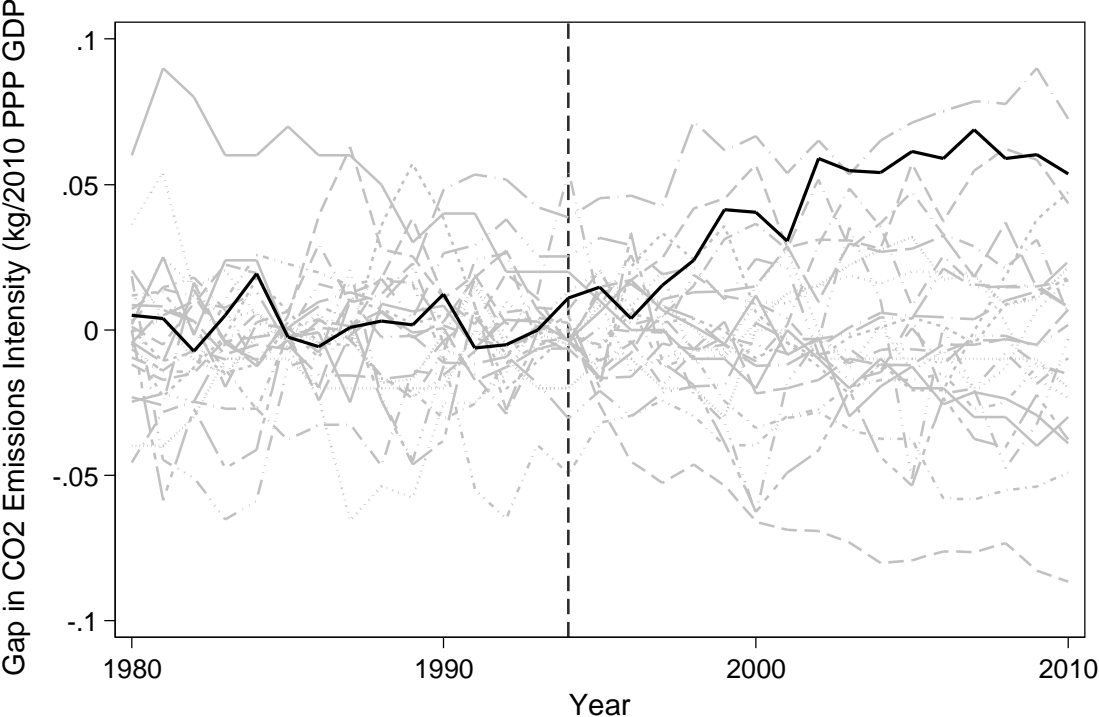
Note: This placebo test assigns the treatment for Japan as having occurred in 1991, the year asset price bubbles in equity and housing burst, precipitating the so-called “lost decade” of economic stagnation. As the figure shows, there is no noticeable divergence between Japan and synthetic Japan in 1991.

Figure 17: Placebo Test: Treatment in 2002 (Ratification of Kyoto Protocol)



Note: This placebo test assigns the treatment for Japan as having occurred in 2002, the year Japan ratified the Kyoto Protocol. As the figure shows, the divergence between Japan and synthetic Japan occurs earlier than 2002.

Figure 18: Permutation Test: CO₂ Emissions Intensity Gaps in Japan and Control Countries



Note: This figure depicts the results of a permutation test in which the synthetic control method is applied to all countries in the sample. The thick line is Japan, and control countries are in gray. As the figure shows, the gap associated with Japan (i.e. the divergence between Japan and synthetic Japan) conspicuously differentiates itself from other countries, with small gaps prior to treatment and a large, positive gap afterwards.