

# The Electoral Politics of Energy Efficiency

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## **Abstract**

Why are some countries more energy efficient than others? Although efficiency improvements are widely acknowledged as a central element of energy security and international efforts to mitigate climate change, the domestic politics of energy efficiency are not well understood. I argue that variation in energy efficiency can be explained by electoral incentives. Energy efficiency is more feasible under electoral arrangements, such as non-majoritarian systems, that allow for the imposition of high, diffuse costs on the general public. This remedies an important roadblock to efficiency in democratic states – public opposition to high energy prices and taxes, particularly in the transportation sector. Ironically, although such electoral systems are generally viewed as poor generators of domestic public goods, their ability to impose diffuse costs makes them effective at the provision of global public goods. I test this theory both qualitatively and quantitatively. First, using a new dataset of transportation trends in thirteen OECD countries, I demonstrate the relationship between energy efficiency and electoral incentives across a range of model specifications and dependent variables. Second, I conduct an in-depth examination of the impact of electoral reform in Japan in 1994 on transportation sector efficiency policy.

## **Introduction**

Since the early 1990s, the management of global climate change has developed into a major topic of international cooperation (von Stein 2008). Human activity has increased atmospheric concentrations of CO<sub>2</sub> from pre-industrial levels of 280 ppm to 379 ppm, the highest level in 650,000 years (Solomon et al. 2007). Greenhouse gases like CO<sub>2</sub> can increase global temperatures by preventing heat from escaping into space, leading to potentially damaging consequences such as rising sea levels, droughts, and flooding (Parry et al. 2007). Although there is some speculative support for geoengineering solutions (Schelling 2006), the predominant response of the international community has been the pursuit of emissions reduction through the creation of international environmental agreements. The existing academic literature on the politics of climate change has also predominantly analyzed the issue as one of international cooperation (Stone and McLean 2004; von Stein 2008; Bättig and Bernauer 2009; Keohane and Victor 2011). However, to date, broad, international climate change cooperation has achieved mixed results at best (Victor 2001; Bättig and Bernauer 2009). Successful CO<sub>2</sub> mitigation ultimately relies on domestic political processes for follow through and implementation.

In this paper, I will make the case that energy efficiency and CO<sub>2</sub> 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 efficiency in democratic states is public opposition to high taxes and energy prices, particularly in the transportation sector (Bättig and Bernauer 2009). In electoral systems that are highly responsive to consumers, such as majoritarian or single-member electoral systems (Rogowski and Kayser 2002; Chang et al. 2010), resistance to higher prices diminishes the ability of governments to encourage energy conservation through the price mechanism. 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 means that, somewhat ironically, electoral systems that are often viewed as poor generators of domestic public goods are effective at the provision of global public goods.

I test this theory both quantitatively and qualitatively. First, I will present quantitative evidence based on a new dataset on transportation sector outcomes among fourteen OECD countries. Consistent with my theory, countries with electoral systems that favor concentrated interests over the unorganized voter – i.e., PR systems and countries with low Cox thresholds – are characterized by higher road/bus share of total travel, lower total travel distances, and greater energy efficiency across a range of measures. Such systems are also characterized by higher diffuse costs on energy use, i.e. gasoline taxes and electricity prices. Over-time variation also provides support for the theory – countries that enacted electoral reform over the past several decades have seen transportation outcomes move in directions consistent with the theoretical predictions.

To supplement the quantitative analysis, I also conduct a case study of Japanese energy policy over the past four decades. Japan's electoral reform in 1994 replaced a multimember district single nontransferable vote system with a mixed-member system dominated by single member districts. Under the old electoral system, legislators were frequently elected with a small share of the vote in each district and therefore had strong incentives to appeal narrowly to organized interests. The new electoral system creates stronger incentives to appeal broadly to the general voter, as the threshold for victory in single member districts is much higher. In effect,

Japan has transitioned from a highly clientelistic political system to one which necessitates broad, public appeal by politicians.

The case illustrates how electoral systems with weak consumers can facilitate energy efficiency. During the oil shocks of the 1970s, Japanese leaders quickly instituted high taxes on automobiles, highway usage, and gasoline that raised the cost of automobile transportation to among the highest in the world. These high costs encouraged energy conservation in the transportation sector, leading to low travel distances (i.e., short commutes), high rail share in total transportation, and an energy efficient vehicle fleet. These measures were made politically tenable by explicitly tying them to particularistic redistribution that benefited favored constituents of the LDP. This response contrasts sharply with political outcomes after electoral reform in 1994. Although Japanese leaders have publicly announced aggressive CO<sub>2</sub> mitigation targets to address global warming, and despite sharp increases in global energy prices reminiscent of the 1970s, recent debates in Japan have revolved around the *elimination* of policies that encourage energy efficiency in the transportation sector. These contradictory forces are illustrated most acutely by the Democratic Party of Japan (DPJ), which came to power in 2009 simultaneously promising to dramatically reduce CO<sub>2</sub> emissions while slashing gasoline taxes, highway tolls, and automobile taxes. I will conclude the paper with a brief discussion of policy implications and suggestions for future research.

### **Theory: The Electoral Context of Energy Efficiency**

Public policy to encourage energy efficiency 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. In some cases, costs are concentrated, as when a particularly energy-intensive sector, such as steel, is targeted for more onerous regulation or taxation. However, oftentimes the costs are diffuse – meaningfully improving country-level energy efficiency outcomes requires changing the behavior of large numbers of citizens incrementally, as is the case with decisions about what temperature to set the thermostat to or whether or not to pay up to purchase a more energy efficient appliance. The transportation sector predominantly falls into the latter category, as many of the crucial decisions that affect total energy consumption – how far to travel, whether to fly or ride the train, what kind of automobile to purchase – are decentralized, individual-level decisions. Government manipulation of such decision making 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). Efficient usage of electricity 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 individuals.

The central premise of my theory is that some domestic institutional arrangements are more conducive to energy efficiency 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). 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 incentivize politicians to appeal narrowly to organized interests, it is relatively unproblematic to impose diffuse costs for the purpose of encouraging energy efficiency. What electoral support is lost from the general public can be compensated by allowing organized interests to benefit from the effects of higher costs. There are two principal mechanisms through which organized groups can be rewarded. First, the revenues generated from taxes levied on energy consuming activities can be redistributed directly to targeted interest groups. For example, it is common cross-nationally 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 – the vast majority of the population in most developed countries – to the construction industry and residents proximate to underutilized roads, such as in rural areas. Second, governments may also allow concentrated interest groups to directly capture the rents associated with high prices (Rogowski and Kayser 2002; Chang et al. 2010). Such mechanisms are less effective in compensating for the negative consequences of imposing high costs on the general public in electoral contexts that necessitate broad, programmatic appeal. For this reason, high, diffuse costs for the purposes of energy efficiency are less likely to be sustainable in such electoral contexts.

What measures best capture the tendency for electoral systems to encourage particularistic policies targeted towards narrow constituents at the expense of the general voter? I focus on two measures identified by existing work on electoral systems. 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 small 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, we would expect countries with low Cox thresholds to be more capable of imposing high costs on general transportation consumption in order to encourage energy efficiency. Although politicians in such countries would lose political support from consumers, higher prices create opportunities to win elections by rewarding a narrow group of constituents through redistributive taxation or the provision of rents.

The second measure I use is a dichotomous indicator of proportional/majoritarian electoral systems.<sup>2</sup> 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 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

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

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 efficiency by imposing high, diffuse costs on the general public.

How do these predictions translate into general energy efficiency outcomes? In electoral systems that create incentives to appeal broadly to voters, one might imagine a different, but equally effective, form of pro-environmental policymaking – i.e., politicians impose heavy, concentrated 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 probably not a feasible political strategy – even in majoritarian systems, a redistributive mechanism with large, highly focused costs and small, diffuse benefits is likely to be hampered by severe collective action problems (Olson 1965). Compared to an automobile driver, the owner of a energy-intensive factory is also more likely to contemplate international relocation in response to onerous government policies (Rodrik 1997). In addition, even if countries with electoral incentives favoring broad appeal are able to achieve superior energy efficiency in the industrial sector, industrial CO<sub>2</sub> emissions are generally small in proportion to emissions associated with diffuse consumption – e.g., in the United States in 2009, the sectoral contributions to CO<sub>2</sub> 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%).<sup>3</sup> Hence, I predict that countries with electoral systems characterized by weak consumer power will also have relatively low overall energy intensity and CO<sub>2</sub> emissions intensity.

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<sup>3</sup> The IEA groups electricity and heat together as a separate category, while the U.S. does not. U.S. Energy Information Administration, *Monthly Energy Review* ( April 2010), Tables 12.2 - 12.6; International Energy Agency, CO<sub>2</sub> Emissions from Fuel Combustion Highlights, 2011 Edition, 9.

## Empirical Analysis

To analyze energy usage in the transportation sector, I use a new dataset collected from national sources on travel distances and energy consumption across transportation modes.<sup>4</sup> Fourteen OECD countries are included in the data – Australia, Canada, Denmark, Finland, France, Germany, Italy, Japan, the Netherlands, New Zealand, Norway, Sweden, the United Kingdom, and the United States. This data includes a range of measures that are not available in conventional databases and allows for the disaggregation of transportation sector energy consumption into individual components. For the purposes of this paper, I focus on three aspects, which are widely recognized as the three principal components of energy consumption in transport: 1. Total distance traveled; 2. transportation mode share; and 3. energy efficiency by mode.<sup>5</sup>

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 on board or obtained through the electric grid – greater travel distances are *ceteris paribus* associated with greater energy consumption.

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 compared to other forms of transportation cross nationally. For example, in Japan, automobile transport consumes about 5.5 times as much energy to carry a passenger the same distance as a train and

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<sup>4</sup> This data was collected in collaboration with Lee Schipper. Rosalind Boone deserves particular mention for excellent research assistance.

<sup>5</sup> For an overview, see Ang (2000).

3.6 times the energy of buses. Even in the United States, where low ridership diminishes the efficacy of public transportation, automobiles consume 2.6 times and 3.0 times the energy of rail and bus respectively.<sup>6</sup> Hence, countries with high rail and bus ridership tend to consume less energy for transportation.

Finally, there is also cross-national variation in energy efficiency within travel modes. The energy efficiency of public transportation depends critically on ridership as already discussed. However, the energy efficiency of automobiles is generally more important, as automobiles consume the lion's share of energy within the transportation sector in most countries. Most analyses of energy policies regarding automobiles focus on regulatory standards, in particular those regarding fuel economy – but *realized* fuel economy often diverges considerably from government regulations. This is because realized fuel economy is also affected by factors such as driving habits and congestion, which are determined by the micro-level decisions of individual drivers. For example, although Japan's automobile fleet has among the best fuel economy test values in the world, realized fuel economy is about 20-30% worse and generally inferior to levels in Western Europe (Millard-Ball and Schipper 2011). Hence, the cost of automobile transportation, such as automobile acquisition, maintenance, and gasoline, shape the choices of individual consumers – whether or not to purchase a car, whether or not to put in on the road, and how to drive. In turn, these can be expected to impact realized fuel economy.

I predict that countries with electoral incentives conducive to particularism – i.e. low Cox thresholds and proportional representation – will be characterized by higher prices for automobile transportation and decentralized behavior consistent with energy conservation across the three dimensions of travel. Citizens will travel shorter overall distances by, among other things, residing closer to locations of employment. They will be more likely to opt for travel by

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<sup>6</sup> Based on data for 2005.

public transportation. Finally, when they travel by automobile, they will travel with greater efficiency due to less congested roadways and because they are more likely to own energy efficient automobiles.

This detailed data on transportation trends allows us to consider potential alternative explanations associated with electoral incentives. For example, it has been argued that PR systems may have better infrastructure due to the more secure tenure of politicians.<sup>7</sup> Better infrastructure could facilitate energy efficiency through the provision of better public transportation and less congested roads. However, if this explanation is correct, transportation *activity* should be higher, rather than lower, in PR systems – superior infrastructure should enable greater travel over longer distances. In addition, the effect of better infrastructure on mode share is ambiguous – infrastructure improvements could be directed towards better roads or better rail transportation. Alternatively, suppose the story is simply one of producer-consumer power, in which producers in PR systems are able to charge higher prices for their products. Higher transportation prices will tend to depress overall travel, and higher energy prices will encourage intra-mode energy efficiency. However, in this case, the prediction for mode share is ambiguous – there is no *prima facie* reason why railroad and bus operators should have less pricing power than gasoline or automobile producers. If anything, the high fixed costs associated with rail infrastructure should give rail operators asymmetrical pricing power compared to more competitive industries such as automobile production. I will discuss the producer-consumer power hypothesis in greater detail in subsequent sections.

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<sup>7</sup> See discussion in Chang et al (2010), pg. 231-233.

## *Cross Sectional Analysis*

Before moving to the panel data, I begin by analyzing cross-sectional data for 1990. Since transportation outcomes generally change slowly, and electoral systems were relatively stable prior to the 1990s,<sup>8</sup> this is a reasonable starting point for analysis. Figure 1 presents an illustrative bivariate scatter plot of bus/rail share of total travel against the Cox threshold for the countries in the dataset. As the figure illustrates, there is a general inverse relationship between the Cox threshold and rail/bus share. This is consistent with the proposed theory: countries with more particularistic electoral systems tend to be characterized by greater travel on energy efficient modes of transportation. Japan is an outlier with a high share compared to other countries, but the inverse relationship is visible even if Japan is excluded.<sup>9</sup>

One obvious control variable suggested by Figure 1 is population density. Large countries with dispersed populations, such as the United States and Australia, may be more prone to air and automobile transportation, which makes it inherently difficult to achieve energy efficiency. I therefore include population density as a control variable in all subsequent model specifications.<sup>10</sup> 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. It is also possible that transportation behavior, and hence demands for government policies, are motivated by local climate conditions. Among countries in the sample, it appears plausible that citizens might prefer to opt for private automobile transportation in

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<sup>8</sup> France adopted PR in 1986 but quickly reverted to a majoritarian system in 1988.

<sup>9</sup> Japan is less of an outlier on other measures such as automobile energy intensity and total distance traveled. Omitting Japan from the sample does not alter the substantive findings in subsequent empirical results.

<sup>10</sup> This variable is measured as 100,000 people per square km.

particularly cold climates, such as in Canada, where the walking and waiting associated with public transportation could be taxing. In alternative specifications, I used variation in daily temperatures, cloud cover, and annual precipitation, and the substantive results were unchanged.

Transportation policy may also be influenced independently by the strength of interest groups with a concentrated interest in energy efficiency outcomes. 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 efficiency policies from primary energy producers. I therefore include proxies for each of these factors in the models.<sup>11</sup> In alternative specifications, I also included controls for trade openness and size of the transportation sector, with no change in the substantive results.

Table 1 presents the results of the OLS regression for the four dependent variables associated with transportation sector outcomes. As predicted, high Cox ratios are associated with low bus/rail share, longer total distances traveled, more energy intensive automobiles, and higher overall transportation intensity.

Table 2 considers several additional dependent variables of interest: gasoline tax levels, electricity prices, energy intensity of the economy, and CO<sub>2</sub> intensity of the economy. Consistent with the theory, the results show that countries with high Cox ratios tend to have lower gasoline and electricity prices. Countries with high Cox ratios are also characterized by greater overall energy and CO<sub>2</sub> intensity.

Table 3 provides a presentation of substantive counterfactuals of interest holding all other variables at their mean values.<sup>12</sup> I also include results from regression using a dichotomous

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<sup>11</sup> Specifically, I use manufacturing and mining share of GDP and the log of oil production.

<sup>12</sup> King et al. (2000)

indicator of proportional representation / majoritarian electoral systems.<sup>13</sup> The first column considers the change from a Cox ratio of 0.5 to 0.2. In the data, this corresponds to a change from Australia to Japan (prior to electoral reform). The second column considers a change from a majoritarian to proportional electoral system. As the table illustrates, the differences associated with these electoral shifts are substantively significant.

### *Change over Time*

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. 2010). It is therefore worth considering the over-time effects of electoral reform on energy efficiency. Three countries in the sample have undergone meaningful, sustained electoral change. As I will discuss in detail later, Japan moved from a single nontransferable vote multi-member district system to a mixed-member majoritarian system in 1994. 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. New Zealand moved in the reverse direction from a Westminster-style majoritarian system to a mixed-member proportional system in 1993. France also underwent electoral reform, but its brief stint with proportional representation in 1986-1988 is unlikely to have had a lasting impact.

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<sup>13</sup> I use the coding from Chang et al (2010).

Table 4 lists these four major episodes of electoral reform and the transportation CO<sub>2</sub> emissions intensity of each country during the decade before and after electoral reform.<sup>14</sup> 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 increasing to declining emissions intensity. Italy's pace of emissions reduction accelerated considerably.

Table 5 reports results from OLS model specifications with country fixed effects. 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. Table 5 reports results using the dichotomous indicator of PR/Majoritarian electoral systems as the key independent variable. As the table shows, PR is associated with the transportation outcomes predicted by the theory – higher bus/rail share, less travel, less energy-intensive automobile travel, and less travel energy per GDP. Although I omit the regression results for brevity, the results are supportive of the theory when the dependent variable is replaced with gasoline prices (higher under PR), electricity prices (higher under PR), energy intensity of the economy (lower under PR), and CO<sub>2</sub> intensity of the economy (lower under PR).

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<sup>14</sup> I use CO<sub>2</sub> emissions intensity as the transportation measures are not fully available for recent years for New Zealand and for Italy after the second reform. The most recent four years are used for Italy's second reform.

In the fixed effect specifications, the Cox threshold produces inconsistent results. This appears to be due to two issues: 1. the number of parties in a political system changes only gradually, even after electoral reform; 2. since electoral reform is generally implemented to redress perceived problems with the preexisting system, conditions immediately following reform tend to be 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. The Cox threshold may therefore not adequately capture shifts in electoral incentives immediately following a change in rules.

#### *Producer Power or Energy Efficiency?*

One interesting question raised by the results presented above is whether the findings may be largely explained by earlier research, which shows that majoritarian systems tend to have lower overall price levels (Chang et al. 2010; Rogowski and Kayser 2002). 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 across the board. Among the low prices enjoyed by consumers is that for energy consumption. Since energy prices are low, consumers will tend to use more energy and be less interested in energy efficiency.

This explanation is not fundamentally at odds with the theoretical account presented in this paper, which argues that incentives generated by the electoral system 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 efficiency 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 and efficiency by raising the costs of energy inputs for consumers.

These are not competing explanations – it is entirely plausible and likely that both mechanisms are at play. However, it is possible to test for two important differences in the observable implications of each causal mechanism. The consumer-producer 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 efficiency 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 efficiency was not an important concern. Similarly, while the producer-consumer power story predicts a similar pattern of price differentials across products, my theory predicts particularly pronounced effects in prices that directly bear on energy efficiency, 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 Kayser and Rogowski (2002).<sup>15</sup> 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 2 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.

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.

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<sup>15</sup> I thank the authors for their willingness to share their data from Change et al (2010). The data was extended using the original sources cited by the authors.

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).<sup>16</sup> In contrast, in 1960, average price levels for SMD countries (84) were 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.<sup>17</sup>

Figure 3 similarly replicates the results from Kayser and Rogowski (2002) across product categories.<sup>18</sup> The results indicate that price differentials across electoral arrangements are focused primarily in energy consumption (gasoline, electricity) and consumption of energy-intensive products (machinery and equipment, transport). In contrast, there is no statistically significant difference between electoral systems in prices for less energy-intensive products such as education, healthcare, and communication.

The primary purpose of this subsection is not to challenge the theoretical and empirical contributions of Chang, Kayser, Linzer, and Rogowski. The theoretical account presented here

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<sup>16</sup> Prices are expressed relative to the United States, with the United States normalized to 100, as in the original analysis.

<sup>17</sup> I replicated and extended the results for the PCSE, between-effects, and Arellano-Bond dynamic panel-data estimation models.

<sup>18</sup> Data on individual product prices are from the International Comparison Program (ICP) of the World Bank, except gasoline and electricity prices, for which data sources were described earlier. 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 constant for a considerable length of time.

draws heavily on their insight that consumers are more weakly represented in proportional representation systems, and that this has implications for cross-national price levels. However, the results presented here suggest that: 1. Government efforts to affect price levels for energy security and environmental purposes may play a larger role than previous work recognizes; 2. Producer power in PR systems may be facilitated by factors such as major price shocks and exogenous factors that give governments a compelling rationale to manipulate price levels. At a minimum, it is unlikely that the empirical results presented in this paper are derivative of lower *overall* price levels in majoritarian systems.

### **Electoral Reform and Energy Efficiency in Japan**

In this section, I will supplement the empirical results presented earlier by examining in greater depth a specific instance of electoral reform: that of Japan in 1994. Japan's electoral system reform is often compared to Italy (Giannetti and Grofman 2011). However, Italy has been characterized by several shifts, from proportional representation to a predominantly majoritarian system in 1993, and back to proportional representation in 2005. Politicians in the final years of majoritarian rule might have anticipated a return to PR, and Silvio Berlusconi, who ruled from 2001 to 2005, appears to have responded primarily to private rather than electoral incentives.<sup>19</sup> In comparison, electoral rules have remained stable since reform in Japan for close to two decades, and studies generally show that politicians have adapted significantly to the new electoral realities (Reed et al. 2012). Japan is increasingly moving towards a two party

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<sup>19</sup> As Chang, Kayser, Linzer, and Rogowski (2010) point out regarding Berlusconi's media empire, "... few electoral incentives could overpower financial self-interest when the head of the government himself was one of the nation's preeminent producers (166)."

configuration motivated by electoral incentives (McElwain 2011). For these reasons, Japan offers perhaps the most compelling “natural experiment” in how electoral transformation impacts the politics of energy efficiency. I will show that electoral incentives played a crucial role in Japan’s energy efficiency achievements prior to reform as well as its subsequent struggles.

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 2005). 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 industry – towards broad appeal to the median voter (Cox et al. 1999; Hirano 2006; Rosenbluth et al. 2010; Rosenbluth and Thies 2010). Indeed, Japan’s political system has increasingly moved towards consolidation under a two party system (McElwain 2011; Scheiner 2011). This shift in electoral incentives therefore provides an opportunity to examine the *prima facie* plausibility of the proposed theory elaborated in this paper.

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. A more expansive account of Japanese policies is available elsewhere (Lipsky 2011; Lipsky and Schipper 2011).

### *The Electoral Politics of Energy Policy 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 efficiency outlined in this paper. 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. 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 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.<sup>20</sup> 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

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<sup>20</sup> 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.

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.

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.<sup>21</sup> 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 Efficiency after Electoral Reform in Japan*

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<sup>21</sup> 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.

The political arrangements that underpinned energy efficiency 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 turn, high transpiration taxes were deeply unpopular among the general public, and entrepreneurial politicians targeted 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 the first prime minister to take 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.

Since the late 1990s, the Democratic Party of Japan has gradually become the LDP's counterpart in Japan's emerging two party system. Like Koizumi, the DPJ has 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.”<sup>22</sup> Ozawa personified the old model of pork barrel politics under the LDP, which he left in 1993. However, under the new electoral system, Ozawa has become 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.<sup>23</sup> Similarly, 57% of survey respondents supported elimination or reduction of the automobile weight tax.<sup>24</sup> 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.<sup>25</sup> The LDP was only able to override this later due to its supermajority in the lower house, which had been secured under Koizumi.

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

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<sup>22</sup> e.g., see “DPJ’s ‘God of Elections’ faces fresh blow,” *Financial Times*, 1-15-2010.

<sup>23</sup> “Naikaku Shijiritsu 41%,” *Kyodo Tsushin Yoron Chosa*, 01-12-2008

<sup>24</sup> “Jidosha no Zeikin Ni Tsuite,” *JAMA Report* No. 91,

<sup>25</sup> 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.

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.”<sup>26</sup>

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 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.<sup>27</sup> 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. As of November 2011, highway tolls are being waived only in the affected areas of the Tohoku region.

Figure 4 depicts the evolution of highway tolls, gasoline taxes, and the automobile weight tax in Japan, with 1970 levels normalized to 100.<sup>28</sup> 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.

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<sup>26</sup> DPJ Manifesto, 2009

<sup>27</sup>“Kosoku Doro no Tomen no Aratana Ryokin Waribiki ni Tsuite,” MLIT Press Release, 2-16-2011.

<sup>28</sup> 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.

The net result has been stagnation in Japan's energy efficiency policymaking. In recent years, European countries such as Germany have responded to global climate change concerns by raising taxes on fossil fuel consumption – e.g., 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 stagnated and currently lies about 30% below the OECD average. The DPJ pledge to repeal the temporary gasoline tax would have brought Japan's rate to a level below Australia and Canada and only slightly above the United States.

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 has sought to portray itself as an environmentally friendly party to appeal to its urban support base. Most notably, one of Prime Minister Hatoyama's signature announcements upon taking office in 2009 was a 25% CO<sub>2</sub> 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%).<sup>29</sup> 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.<sup>30</sup> In short, Japan is not falling behind because the public or policymakers have suddenly become environmental skeptics.

## Conclusion

In this paper, I have argued that electoral incentives play an important role in facilitating or obstructing energy efficiency and the mitigation of greenhouse gas emissions. In particular, electoral systems that encourage narrow targeting are more effective at achieving energy efficiency than systems that incentivize broad, popular appeal. Hence, somewhat paradoxically, political systems that are poor providers of domestic public goods excel at the generation of global public goods. I presented a range of empirical evidence in support of this theory, utilizing a new dataset on transportation sector energy consumption as well as other widely available indicators of energy efficiency. A case study of Japan illustrated how electoral reform weakened the foundations of Japan's traditional energy efficiency policies. In this final section, I will discuss several additional issues and suggestions for future research.

Many of the arguments made in this paper about electoral systems would also seem to apply to autocratic governments. Like political 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). Holding intentions constant, this is likely true. China, for example, has adopted energy efficiency targets in its

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<sup>29</sup> Ministry of Foreign Affairs (Japan), "Chikyu Kankyo Mondai ni Kansuru Ishiki Chosa," 2005.

<sup>30</sup>"Chikyu Ondanka Taisaku ni Kansuru Yoron Chosa," Cabinet Office, Government of Japan, 8-2007.

recent five year plans, and this has been accompanied by aggressive tactics to secure compliance, such as cutting off electricity to parts of the country and the implementation of a national gasoline tax.<sup>31</sup> However, as Bättig and Bernauer (2009) show, autocratic states appear to be less interested in addressing global warming in the first place. Insofar as this changes, for example if more autocracies become actively involved in global climate change mitigation efforts, there are grounds to believe they will be reasonably effective, particularly vis-à-vis the transportation sector.

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, it may be worth reassessing the consumer-producer balance story by disaggregating production costs that are likely to be associated with externalities, particularly energy costs.

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, international environmental commitments are likely to encounter particular difficulty in implementation. It is striking that a Japanese

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<sup>31</sup> e.g., “China Focus: Five-year Plan to Cut Pollution,” *Financial Times*, 11-26-2011; “What to Expect from Fuel Tax Implementation in China,” *Frost & Sullivan Market Insight*, 5-29-2009.

foreign ministry official in 2011 described the Kyoto Protocol as embodying a “European top-down approach” that is not a good fit for Japan.<sup>32</sup> However, it is not clear how a bottom-up approach will work – Japan’s population is already gravely concerned about global warming, and yet policy measures to raise prices on energy-intensive transportation are deeply unpopular. If global climate change is to be effectively addressed, it will be important to move beyond international commitments and devise mechanisms to address these domestic political roadblocks to implementation.

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<sup>32</sup> Personal interview, Official of the Climate Change Division, Japan Ministry of Foreign Affairs, 6-7-2011.

**Table 1: Cox Threshold and Transportation Sector Outcomes, 1990 OLS**

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)
Cox Threshold	-0.57* (0.24)	13.62* (5.00)	3.11* (1.24)	3.45* (0.43)
Population Density	0.04 (0.23)	-7.89* (2.46)	-1.01 (0.74)	-0.45 (0.26)
GDP/Capita	0.04 (0.04)	2.20 (1.64)	0.27 (0.31)	-0.26* (0.10)
Annual Mean Temperature	0.01 (0.00)	-0.11 (0.09)	0.01 (0.02)	-0.02 (0.01)
Manufacturing Share of GDP	0.47 (0.90)	-16.11 (9.62)	4.78 (2.85)	-0.50 (0.69)
Oil Production	-0.04 (0.05)	0.10 (0.18)	0.01 (0.03)	-0.01 (0.02)
Constant	0.09 (0.26)	9.86* (3.86)	0.45 (0.83)	0.92* (0.23)
R <sup>2</sup>	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.

**Table 2: Cox Threshold and Energy Prices & Overall Energy Intensity, 1990 OLS**

Indep Vars/ Dep Vars	Gasoline Taxes (PPP US \$ / L)	Electricity Prices (PPP US \$ / Kwh)	Energy Intensity (kg of oil equivalent / GDP in \$US 2005 PPP)	CO <sub>2</sub> Emissions Intensity (kg / GDP in \$US 2005 PPP)
Cox Threshold	-1.52* (0.53)	-4.32* (1.42)	0.45* (0.07)	1.19* (0.45)
Population Density	0.05 (0.33)	-0.61 (1.38)	-0.01 (0.05)	0.10 (0.22)
GDP/Capita	0.08 (0.13)	0.42* (0.17)	0.00 (0.02)	-0.00 (0.12)
Annual Mean Temperature	0.01 (0.01)	0.04* (0.01)	-0.01* (0.00)	-0.00 (0.01)
Manufacturing Share of GDP	-0.94 (1.82)	-0.55 (4.08)	-0.20 (0.14)	0.37 (0.90)
Oil Production	0.01 (0.01)	0.02 (0.03)	-0.01* (0.00)	-0.00 (0.02)
Constant	0.73 (0.57)	1.15 (1.15)	0.22* (0.05)	0.02 (0.32)
R <sup>2</sup>	0.58	0.79	0.91	0.58
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.

**Table 3: Counterfactuals of Interest**

Dependent Variables	Decrease Cox Ratio from 0.5 to 0.2 → More Particularistic	Change from Majoritarian to PR → More Particularistic
Rail & Bus Share of Total Distance Traveled	0-33 percentage point increase in share of rail & bus travel	1-14 percentage point increase in share of rail & bus travel
Total Distance Traveled	1.5-20.9 km less travel per day per person	1.2-11.2 km less travel per day per person
Automobile Energy Intensity	0.1-1.8 MJ less energy used per vehicle km (or 0.1-2.2 less gallons of gasoline per 100 miles)	0.4-0.6 MJ less energy used per vehicle km (or 0.5-0.8 less gallons of gasoline per 100 miles)
Travel Energy / GDP	0.7-1.3 PJ less energy used per billion US\$ 2000 PPP	0.1-0.4 PJ less energy used per billions US\$ 2000 PPP
Gasoline Price	\$0.08-1.00 more per liter of gasoline (or \$0.32-3.80 more per gallon) (\$US 2000 PPP)	\$0.18-0.52 more per liter of gasoline (or \$0.7-2.0 more per gallon) (\$US 2000 PPP)
Electricity Price	2-20 cents more per Kilowatt hour of electricity (or \$23-186 more per month for average US household) <sup>33</sup> (\$US 2000 PPP)	0-9 cents more per Kilowatt hour of electricity (or \$3-83 more per month for average US household) <sup>34</sup> (\$US 2000 PPP)
Energy Intensity of the Economy	0.08-0.19 less energy use (kg of oil equivalent) per GDP (\$US 2005 PPP)	0.01-0.10 less energy use (kg of oil equivalent) per GDP (\$US 2005 PPP)
CO2 Emissions Intensity of the Economy	0.03-0.68 less CO2 emissions (kg) per GDP (\$US 2005 PPP)	0.03-0.29 less CO2 emissions (kg) per GDP (\$US 2005 PPP)

Note: Counterfactuals generated from models in Table 1 and Table 2 and comparable specifications using a dichotomous indicator for PR/Majoritarian as the dependent variable, holding all control variables at their mean values (King et al. 2000). Ranges are 95% confidence intervals.

<sup>33</sup> Calculated based on 2005 average U.S. household electricity usage of 938 kwh (U.S. Energy Information Administration).

<sup>34</sup> Calculated based on 2005 average U.S. household electricity usage of 938 kwh (U.S. Energy Information Administration).

**Table 4: Electoral Reform and Change in Transportation CO<sub>2</sub> Intensity (kg per 2005 PPP US\$)**

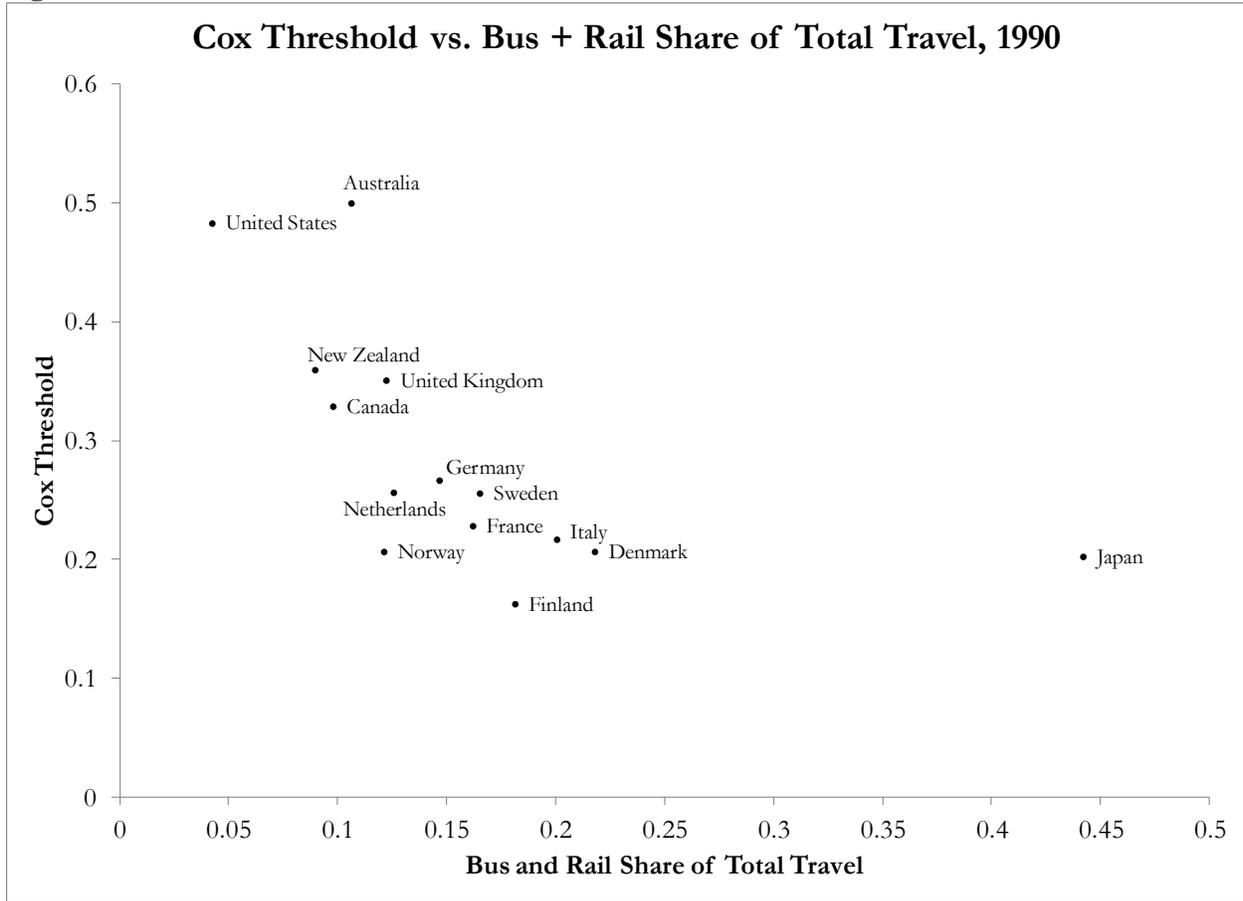
Country and Year/Type of Electoral Reform	Change in CO <sub>2</sub> Intensity, 10 Years Before Electoral Reform	Change in CO <sub>2</sub> Intensity, 10 Years After Electoral Reform	Difference in Change, Majoritarian - PR
Japan (1994) PR → Majoritarian	-13.8%	-0.8%	13.0%
Italy (1993) PR → Majoritarian	-9.2%	-2.5%	6.7%
New Zealand (1993) Majoritarian → PR	18.8%	-8.4%	27.2%
Italy (2005) Majoritarian → PR	-2.0%	-12.8% (4 years)	10.8%

**Table 5: Electoral Rules and Transport Outcomes, OLS with Fixed Effects**

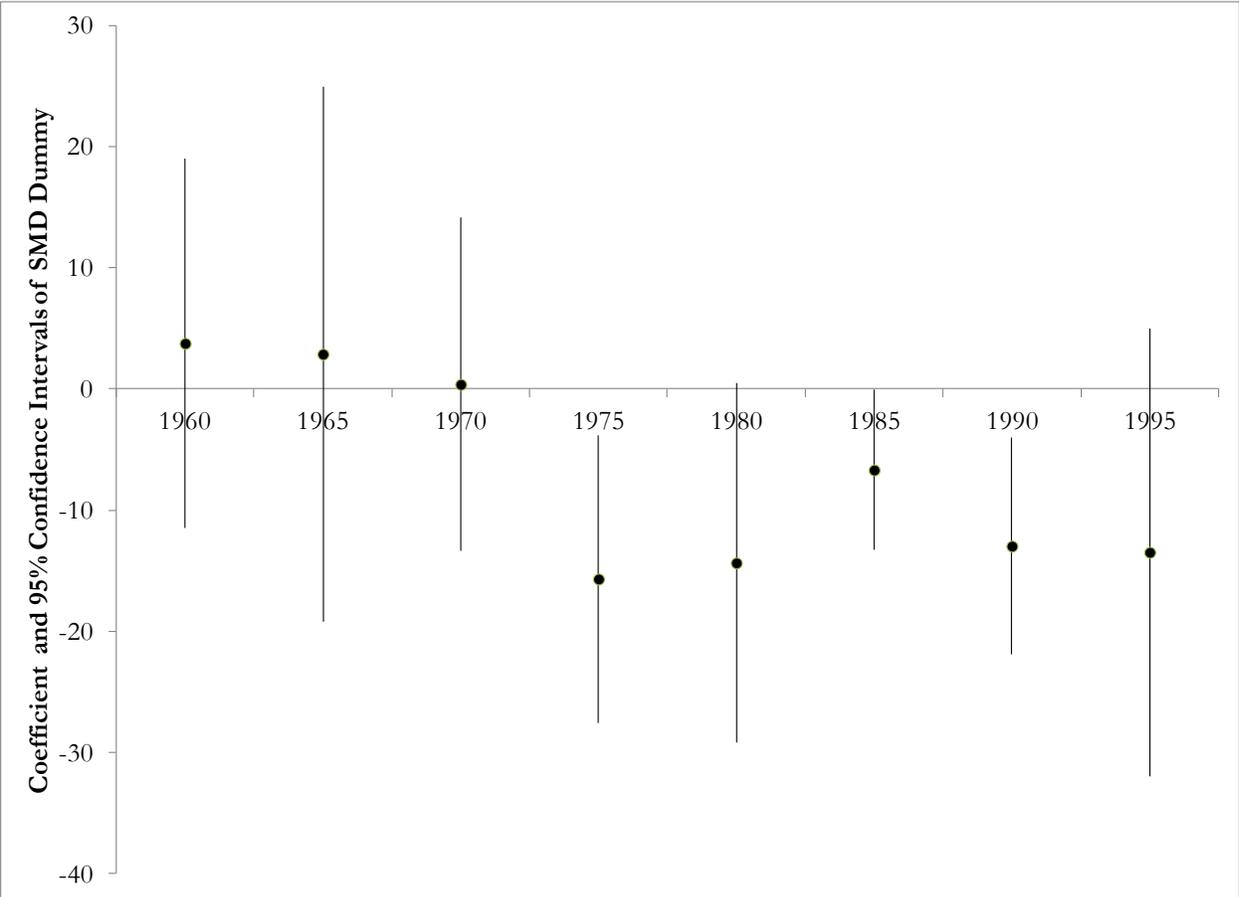
Indep Vars/ Dep Vars	Rail & Bus Share of Total Travel (% of Passenger kilometers )	Total Distance Traveled (1000 kilometers per capita, annual)	Automobile Energy Intensity (MJ/Vehicle km)	Transportation Energy per GDP (PJ/billions of \$US 1990 PPP)
Proportional Representation	0.03* (0.01)	-0.44* (0.14)	-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 <sup>2</sup>	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.

**Figure 1**

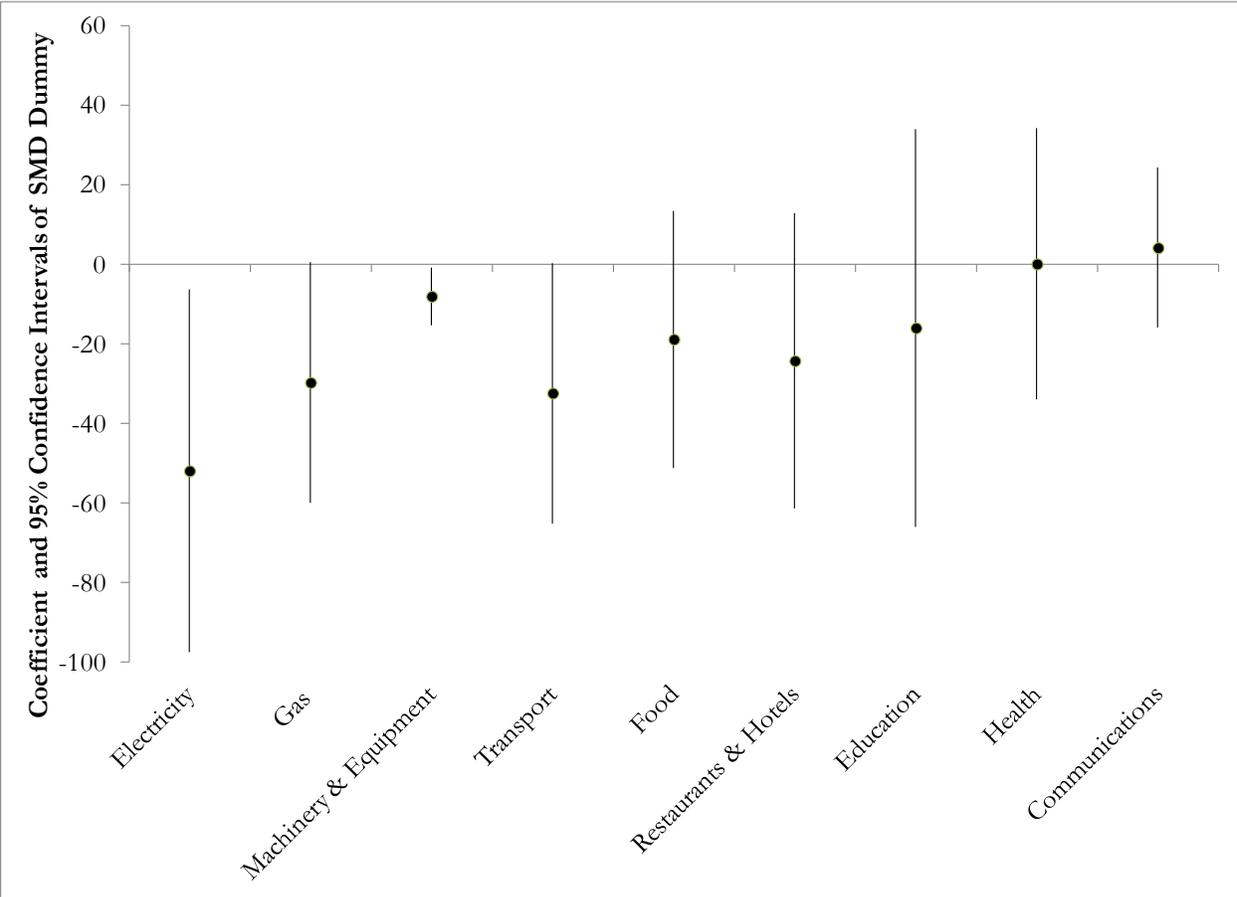


**Figure 2: Replication and Extension of Kayser and Rogowski (2002), Over Time**



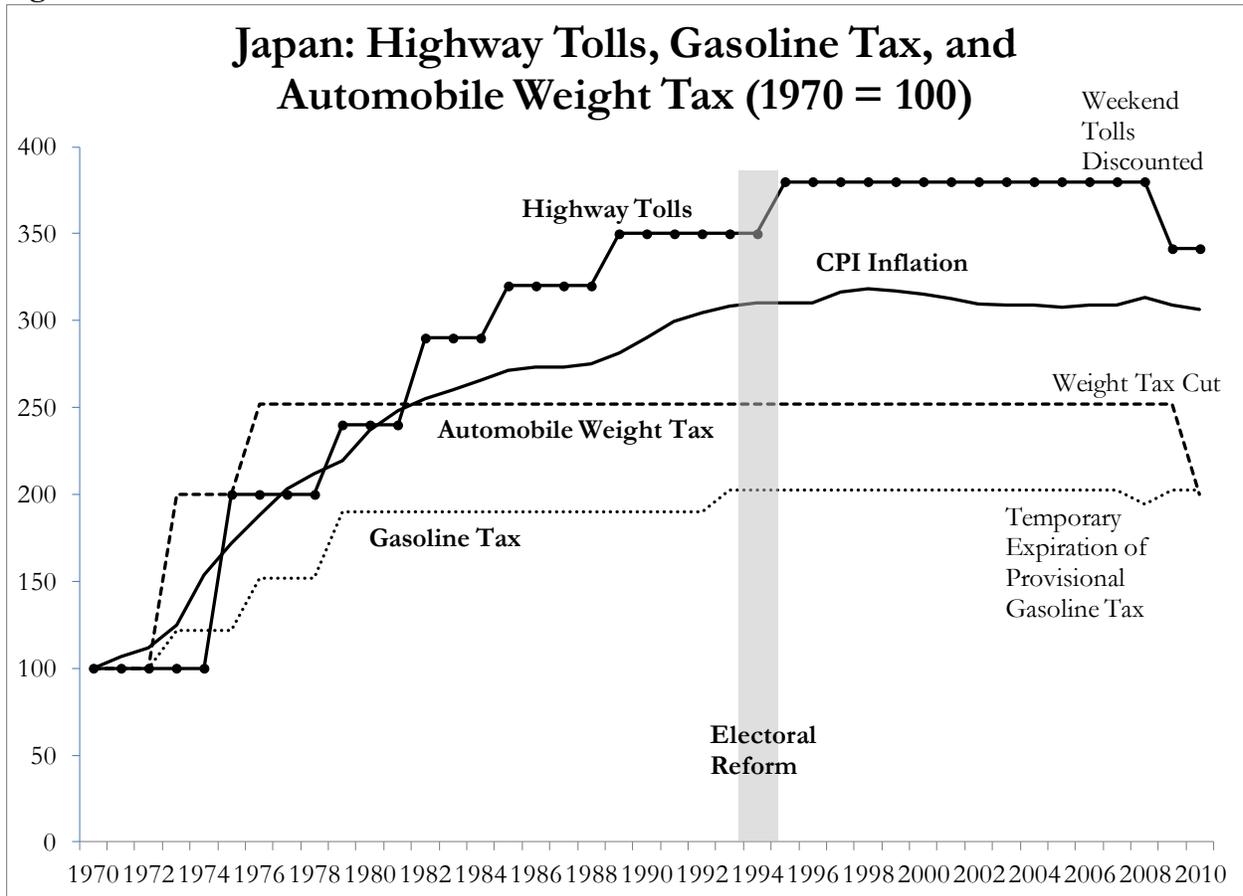
Note: the dots represent coefficients, and lines 95% confidence intervals, from model specifications where price levels are the dependent variable and a dichotomous indicator of single member district (SMD) electoral system is the key independent variable. The results show that SMD is associated with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

**Figure 3: 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 energy consumption and 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.

Figure 4



Source: MLIT, Cabinet Office

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