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Emission Impossible? Political Determinants of Compliance with the Kyoto Protocol

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An abstract of
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Abstract

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The battle against global warming has become a salient issue in not just the environmental sphere but also the political realm. In order to combat global warming and its cause, the emission of greenhouse gases, the Kyoto Protocol was created. Yet states vary widely in their level of compliance with the treaty's provisions for reducing carbon emissions. This paper identifies a number of political factors that might explain that variation, from the role of environmental parties, "dirty industry" pressure groups, and the electoral cycle, to cross-country policy contagion. To test the impact of these variables alongside that of the basic pressures of economic growth and population size, I estimate a multivariate regression of compliance with Kyoto Protocol carbon emission targets. The results suggest that some of these political factors have a strong influence on compliance patterns.

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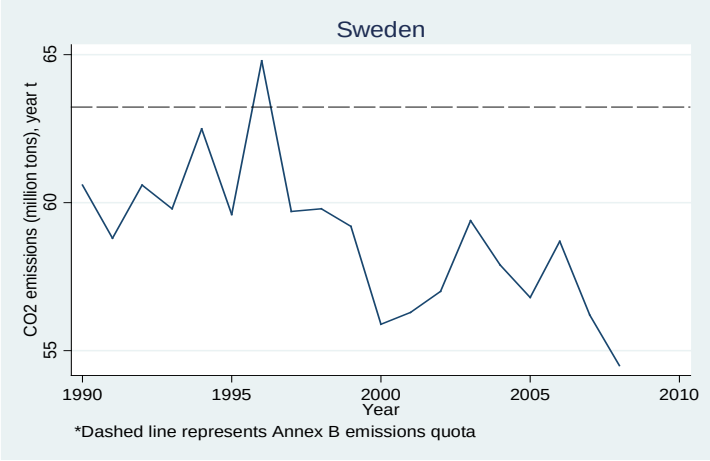
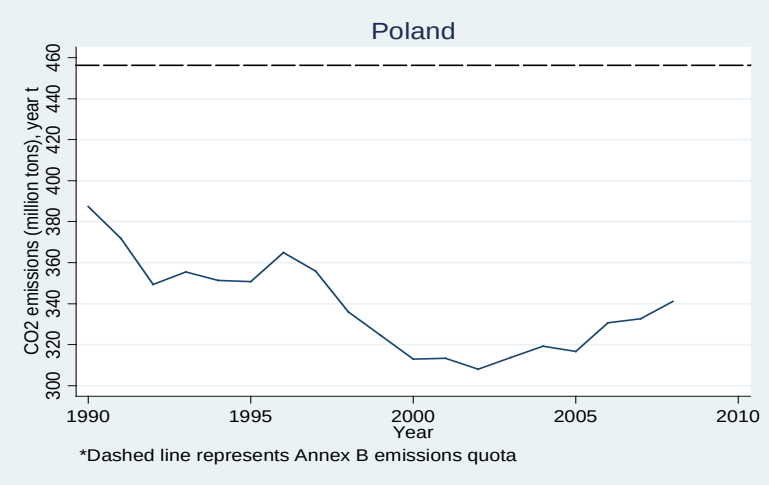
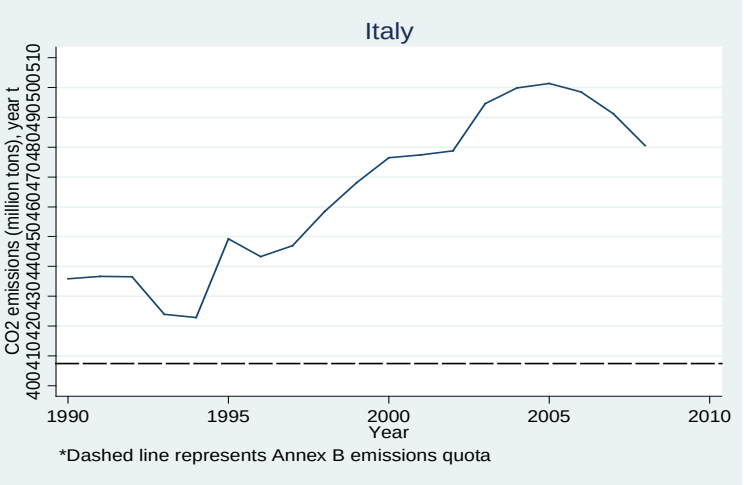
Introduction

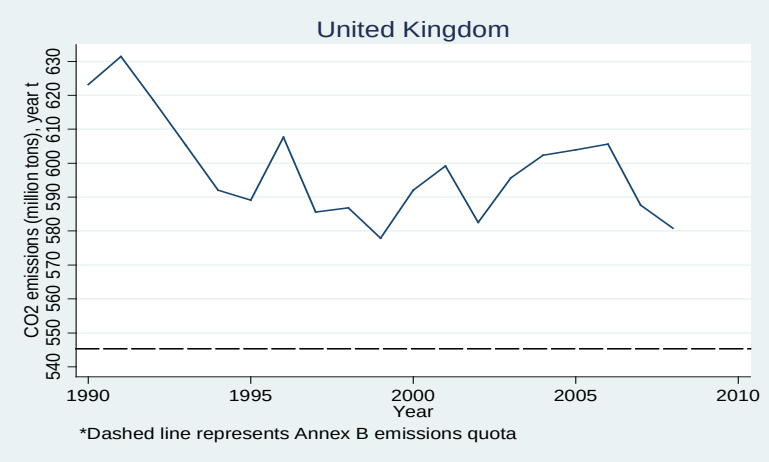
Why are certain countries on track to meet their Kyoto Protocol targets for carbon emissions while others are not? Clearly variation exists as to whether or not countries are on track to comply with their Kyoto targets as illustrated by this graph (Graph 1) of carbon emissions in a few select countries party to the Kyoto Protocol. I have also included a complete graph (Graph 2) of the percent by which countries are exceeding their 1990 emissions benchmark and their targets relative to this benchmark.

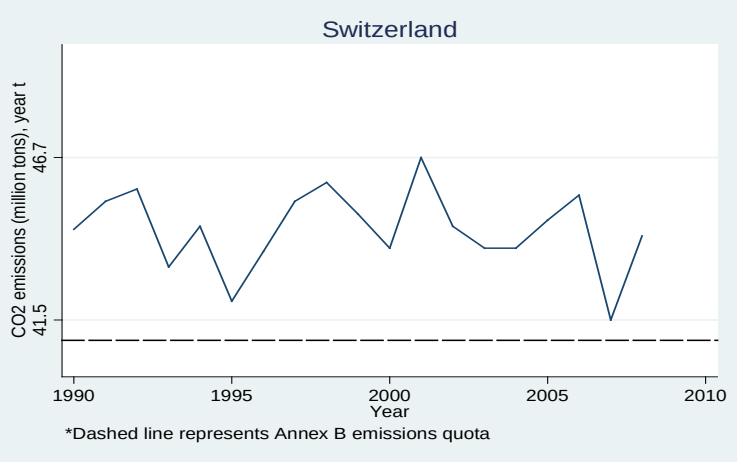
Graph 1 (Continues to next page)
Carbon Emissions of Selected Countries




Poland
CO2 emissions (million tons), year t
300 320 340 360 380 400 420 440 460
1990 1995 2000 2005 2010
Year
*Dashed line represents Annex B emissions quota

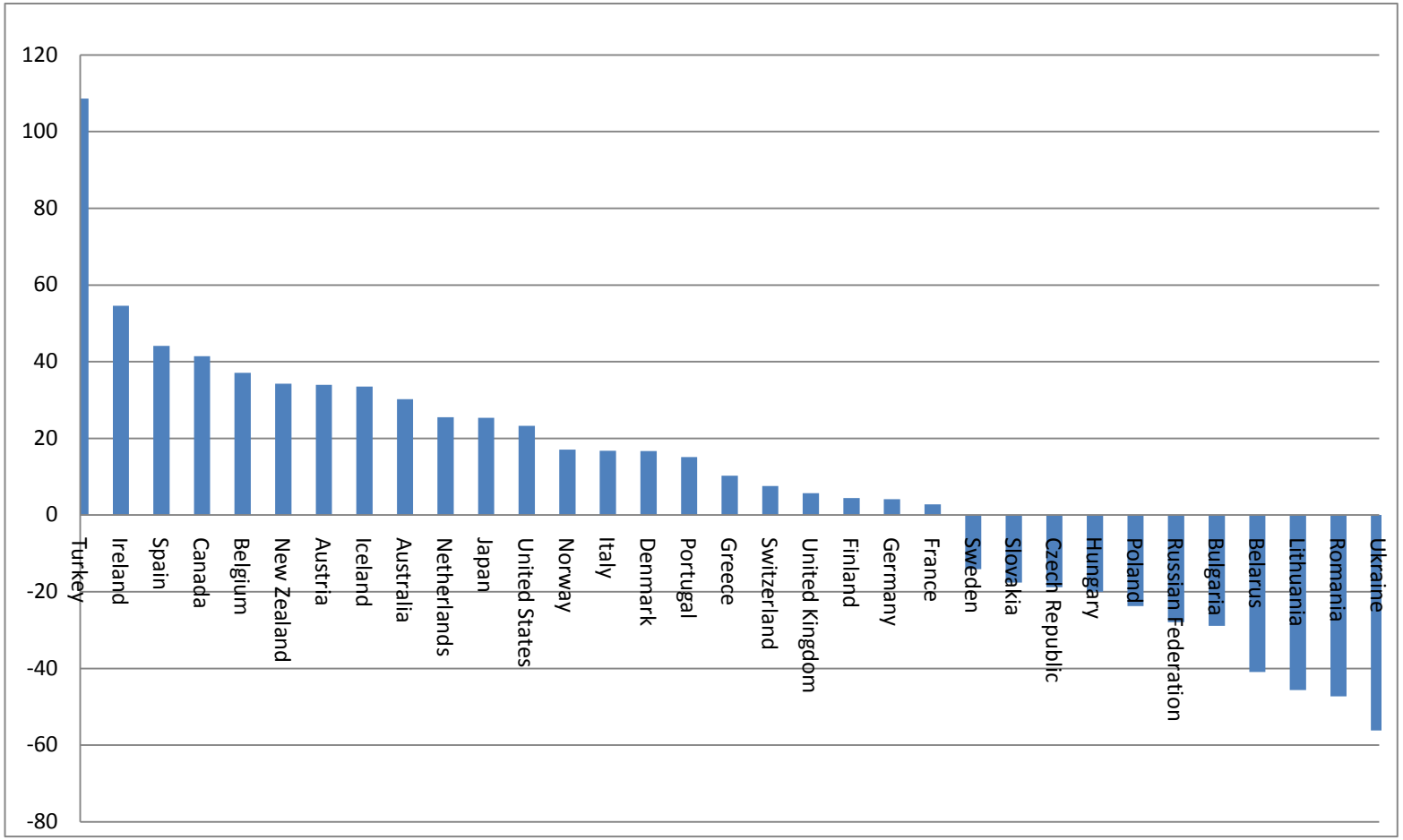

Italy
CO2 emissions (million tons), year t
400 410 420 430 440 450 460 470 480 490 500 510
1990 1995 2000 2005 2010
Year
*Dashed line represents Annex B emissions quota


United Kingdom
CO2 emissions (million tons), year t
540 550 560 570 580 590 600 610 620 630
1990 1995 2000 2005 2010
Year
*Dashed line represents Annex B emissions quota


Switzerland
CO2 emissions (million tons), year t
41.5
46.7
1990 1995 2000 2005 2010
Year
*Dashed line represents Annex B emissions quota

Graph 2

% over Kyoto Carbon Emissions Quota as of 2008



This paper will examine and identify the political variables that drive compliance with the Kyoto Protocol. I have opted to limit my research to the countries party to Annex I of the treaty, which governs the reduction in greenhouse gas emissions required of the developed world. This is because only the developed countries listed under Annex I are subject to an actual emissions target which allows me a means to gauge their compliance. It should be noted that this method forces me to exclude important large scale emitters such as China and India which are not party to Annex I and therefore have no target against which to measure their compliance.

Why should we care about carbon emissions? Global warming has an extremely powerful effect on the environment and is potentially dangerous to people the world over. For example, in the US the EPA found that carbon dioxide emissions endanger human health and well-being.[1] Furthermore, global warming is a rapidly emerging phenomenon and requires global cooperation in order to effectively be dealt with. For these reasons the Kyoto Protocol is an exceedingly important treaty because it is the only binding international treaty regarding climate change in existence. It is not intended to be the final effort at curbing green house gas emissions and is therefore vital to understand the political constraints and influences on compliance to an international treaty on climate change.

[1] Link from http://epa.gov/climatechange/index.html, 74 FR 66496.

Background

I chose this topic because the threat of global climate change is one of the most pressing issues facing the world at large. Stabilization of the global climate will depend on stabilization of the concentration of so-called "greenhouse gases," those gases which trap heat in the atmosphere and thereby cause global warming. This stabilization of greenhouse gas concentrations can be achieved only by a reduction of new emissions in the global commons, accompanied by the capture and sequestration of existing greenhouse gases from the global atmosphere. Achieving a large scale reduction in new greenhouse gas emissions will require immense behavioral changes (Holzinger 2008). In order to achieve this goal the *United Nations Framework Convention on Climate Change* was drafted in 1992. Its stated purpose was the stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system,"[2] and this framework served as the base for the Kyoto Protocol.

Under the Climate Change Convention, the ratifying Members agreed to "address" greenhouse gas emissions and take global climate change "into consideration." Additional obligations were imposed on "Annex I Parties," being those parties specifically listed in Annex I to the Convention. Those Parties comprised almost all of Europe[3], plus Canada, USA, Japan, Australia and New Zealand; and they

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[2] The Convention can be found at: http://unfccc.int/not_assigned/b/items/1417.php

[3] The Annex I list of European countries includes Iceland to the west and Russia and Turkey to the east, but excludes Moldova and the Balkan states of Albania, Bosnia and Herzegovina, Montenegro, Serbia and Kosovo.

additionally agreed to adopt greenhouse gas policies and to reduce emissions "with the aim of returning individually or jointly to their 1990 levels" averaged over the 2008-2012 initial compliance period. These Annex I countries are of particular interest to me because the only way to measure compliance is through the additional obligations these countries agreed to follow. The USA is an outlier in this group as it signed but failed to ratify the Protocol and therefore is not subject to the mandatory emission reduction timetable.

After the Convention entered into force in 1994, the parties held an implementation meeting in 1995, and the first decision at the first meeting was an agreement to strengthen the Convention for the years after 2000 by means of a legally binding protocol to "to set quantified limitation and reduction objectives within specified time-frames" for the Annex I countries.[4] Unfortunately, they also agreed to "not introduce any new commitments for Parties not included in Annex I." These decisions, named the "Berlin Mandate" by the US Under Secretary of State, completely missed the forthcoming dramatic growth in emissions from China and other rapidly industrializing countries.

The Kyoto Protocol, the first decision of the third Conference of the Parties in 1997, attempted to realize these climate change goals by requiring the Annex I parties to reduce their carbon dioxide equivalent emissions to a specified percentage of their base year emissions, as set forth in Annex A thereto, averaged over the initial

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http://unfccc.int/essential_background/convention/background/items/1346.php

[4] http://unfccc.int/resource/docs/cop1/07a01.pdf#page=4

commitment period of 2008 to 2012.[5] (The base year was generally set at 1990, with exceptions as approved by the parties. For some parties the allowed emissions exceed 100% of the base year.) However, the Kyoto Protocol did not enter into force until November 5th, 2005 when it reached the required 55% threshold of developed country greenhouse gas emissions with Russia ratifying it.

Kyoto attempts to facilitate realization of these climate change goals through its 'flexible mechanisms.' These mechanisms are designed to operate using the free market in order to most efficiently reduce carbon emissions. The first of the three prongs to the mechanism is emissions trading. The amount of permitted carbon emission is capped and polluters must acquire allowable emission units equal to the amount of pollutant they are emitting. This means that the emitter can either pay to continue current practices or avoid the fees by reducing emissions. If an emitter chooses to continue business as usual and pay, then another person selling them the emission unit must reduce its emissions in order to generate surplus units for sale. This reduces overall emissions within the country, which is how Kyoto is scored. This process takes what had previously been a positive externality (low carbon emissions) and incorporates that into the market as a good. The next prong is the clean development mechanism which allows Annex I countries to be earn credits against their own carbon emissions by investing in carbon reductions in non-Annex I countries. The third prong, joint implementation, similarly allows countries to earn credits for emission reducing investments, but by doing so in other Annex I countries. These flexible mechanisms

[5] http://unfccc.int/resource/docs/cop3/07a01.pdf

allow for greater efficiency as emitters can seek out the lowest costs; to go for the lowest fruit from the tree so to speak. This is because under the rule of diminishing returns, it might be difficult and costly for a wealthy nation to reduce its own emissions by a certain amount but the same reduction could be had comparatively cheaply and easily in a less developed nation. Thus these mechanisms mean countries can get the greatest bang for their buck.

At the fifteenth Conference of the Parties held in Copenhagen in late 2009 the consequences of the Berlin Mandate, prohibiting reduction commitments for non-Annex I parties, finally became apparent. This conference was supposed to plan for a second commitment period from 2013 to 2017. However, the current parties would not go forward without a commitment by the United States and, in turn, the US would not go forward without a commitment from China. China will at some point agree to become an Annex I country. Until that time, further progress on emission reductions will likely be limited to voluntary actions by individual nations or the European Union.

Literature Review

In order to understand the many factors at work in the Kyoto Protocol I will first examine international regimes as a whole and attempt to provide a base of understanding for the various problems and complications surrounding such institutions. From this background I will draw a specific view of the Kyoto Protocol and seek a hypothesis that I think best predicts and explains the varying levels of compliance with the treaty.

Transnational environmental issues are no longer novel at this point in time, and the situation regarding the Kyoto Protocol is neither new nor unique in political science. The Protocol creates a situation in which the costs of a particular course of action are restricted to certain countries but the rewards of their actions are widely diffused among all countries, so that the rewards received by individual cost bearing countries certainly are not proportional to the costs they have borne. This means there is a particularly strong incentive for the cost bearing countries to choose to free ride instead (Dai 2005). International treaties can help address this issue by offering information on compliance for all cost bearing countries and by facilitating reciprocity of compliance. The situation is not unlike the prisoner's dilemma game because, without the treaty, each state is unsure whether or not the others will cooperate in a situation where free riders will benefit from other states' compliance regardless of their own actions. This can be combated by making sure each state's actions are transparent and each state is well informed in regards to the other states. This openness will promote cooperation and, if properly implemented, should ultimately lead to the most beneficial equilibrium for all cost bearing countries.

Similarly Simmons noted that compliance with international regimes sometimes follows a 'snowball' effect (Simmons 2000 *Money & the Law*). This effect means that once a country, or a few countries, begins to comply then the surrounding countries also will start to comply. Under this theory, the countries that originally ratified the Kyoto Protocol would begin to exert pressure for their neighbors to emulate and likewise those countries that are complying will generate compliance in other countries.

Simmons explains this effect through governments' desires to maintain their reputation and standing among nearby countries. Further, as more countries comply the incentive for other countries to do so also grows. This is because the consequential reputation damage becomes focused on fewer countries rather than diffused among many non-compliers. However, I don't believe this to be driving force behind diffusion.

Realists attempt to explain compliance in a different way. Morgenthau explains that states work through convergent interests and prevailing power relations. States are not actually giving up sovereignty but merely attempting to improve their own situation. Relationships between states are asymmetrical meaning that one state exerts a greater influence and may therefore have a greater pull over the actions of the other state (Simmons 1998). Therefore the choice to comply may not be a purely voluntary decision by a state and instead be the partial result of some form of coercion. Realists instead refer to the particular amount of power a state has, or its parochial interests, to explain actions. For this reason I expect that diffusion will work by neighbors taking cues from the most powerful and influential states around them. These more powerful states can coerce lesser states into pursuing policies more congruent with their desires. For example, if a strong state is complying with the Kyoto Protocol it could also influence weaker state to also comply while a weaker state would not exert the same pull over a stronger state.

Domestic regime type has also been examined for the role it might play in compliance with international agreements (Slaughter 1995 as cited in Simmons 2000).

This stems from the idea that constitutional constraints carry over into foreign policy and go hand in hand with the notion of democratic peace (Dixon 1993, Risse-Kappen 1995 as cited in Simmons 2000). This idea taps also into the liberal school of political thought (Dixon 1993 as cited in Simmons 1998). Furthermore democratic countries with independent judiciaries are more likely to comply with international law because of their exposure to, and familiarity with, a separate judicial branch at the domestic level. A possible counter-argument centers on the role of veto players. Democracies have more veto players in their government and therefore, as the number of veto players increases, it becomes increasingly likely that one of the veto players will veto the compliance. However, I do not believe this variable will play a significant role in influencing compliance among Annex I countries because they are all democracies. Therefore, I will be excluding domestic regime type from my explanation of the variance.

Domestic regimes are also more likely to be subject to influence by special interest groups that may have their own incentive for seeing compliant behavior (Young 1979, Schachter 1991 as cited in Simmons 1998). These groups could influence the government through lobbying. Of particular interest to my study would be the lobbying strength of the fossil fuel industry. This industry generates an immense amount of wealth in many countries and has many large powerful corporations such as Gazprom in Russia or British Petroleum in the UK. These companies alone are quite capable of large scale lobbying efforts individually, and even more so as an entire industry. This industry would take a disproportionate share of the cost burden to reduce carbon emissions in

order to comply with Kyoto targets. Therefore, I would expect the fossil fuel industry to work politically to oppose compliance with the Kyoto Protocol.

The idea that these domestic factors determine compliance is also supported by Xinyuan Dai. Dai uses a case that is somewhat similar to the Kyoto Protocol, the 1979 Convention on Long Range Transboundary Air Pollution. Dai examines why countries comply with international legal agreements even if they do not have the transparency necessary to reach cooperative equilibrium with other countries. His explanation is that there are domestic factors at play that induce the country to comply. He conceptualizes government as an agent that acts on behalf of a specific group of constituents, and that it is the domestic leverage of certain groups within the state that ultimately determine compliance on a national level. For this reason I expect the size and strength of the environmental constituency to have a significant impact on whether or not a state complies. The larger the base the more power it wields and the more it influences compliance. I would expect that the larger the more powerful the environmentalist parties in a country, the more likely that country is to comply.

The idea that the desire to be re-elected drives political motive is not at all new or surprising. Frye and Mansfield (2004) examined the effect of electoral cycle on trade liberalization in post-soviet bloc democracies and found that trade liberalization was far more likely after an election cycle. For this reason I have also included election cycle as a political factor that might influence compliance with the Kyoto Protocol. With something like the Kyoto Protocol the rewards are not immediate reaped, rather they are realized over a relatively long period of time and the costs are immediate. This

opposes the positive conditions periodic elections create in that candidates tend to avoid actions that are costly and could hurt their chances of re-election, and this then causes them to disregard possible future gains. For this reason, I suspect that election cycle will impact compliance by driving countries away from complying in election years.

Compliance is said by Oran Young (1979 as cited in Simmons 1998) to occur when the "actual behavior of a subject conforms to prescribed behavior, and non-compliance or violation occurs when actual behavior departs significantly from prescribed behavior." Compliance does not equate to effectiveness. For this reason my dependent variable will not just be whether or not a country is on track to be under its Kyoto benchmark. The appearance of compliance in and of itself does not demonstrate a causal relationship between an international legal agreement and the behavior (Simmons 1998). This definition highlights the issue as to how to determine whether a causal relationship exists. For example, former USSR countries experienced economic decline around 1990 when the Soviet Union dissolved and their economies transitioned to the free market. This economic decline was met with a decline in energy usage and, as a consequence, a decline in carbon emissions having nothing to do with the Kyoto Protocol. I will control for these economic effects in model so they do not cloud the actual political forces driving compliance.

In order to better gauge the effectiveness of compliance Von Stein suggests reasoning from the counterfactual. Theoretically this would control for the endogenous selection bias otherwise said to be inherent in the study of international regimes.

Reasoning from the counterfactual would mean that in order for the treaty to demonstrate effectiveness a compliant country would have to exhibit less compliance if no such treaty were in place. . Or, in the case of a non-compliant country, it would comply more if it were to adopt the treaty and its obligations (Von Stein 2005). However, this is not possible in my case because I cannot simply erase the Kyoto Protocol and see how the different countries react. Nor can I get the US to ratify the treaty and see what changes occur. The best I can do is introduce the US to my model and observe the impact. I will use this model to demonstrate whether or not countries are actually complying with the agreement or just going about their normal business.

Hypothesis

Based on the literature regarding the Kyoto Protocol and international regimes in general, I believe that the best political explanation for variance in compliance with the Kyoto Protocol is neighbor emulation and the diffusion of policy between nearby states. Initial research had shown that economic growth had been a good indicator of failure and success at compliance, for example most Eastern European states are going to meet their Kyoto goals. However, if one controls for the economic decline of post-Soviet governments this growth explanation looses a lot of steam. Furthermore some countries, for example the UK, have successfully reduced greenhouse gas emissions and are on track to go beyond their Kyoto target despite having experienced economic growth. The fact that neighboring countries have adopted and succeeded in complying with the international regime places pressure on those that have not yet done so. Due

to the fact that relations between states are asymmetrical, the relative political strength and amount of greenhouse gas emissions of these countries is likely to play an important role in policy diffusion. For example, Belgium is less likely to exert this sort of pressure than France both because France is a greater emitter of greenhouse gas and because France in general has greater political pull.

Research Design

Country Coverage. The population scope of my analysis of the determinants of compliance with the Kyoto Protocol is, broadly speaking, the 40 "Annex I" countries listed in the Protocol. These countries have made commitments to specific targets, thus defining the benchmark against which compliance can be measured. However, in practice, some of these must be excluded. The United States, for instance, alone among the Annex I signatories did not ratify the Protocol, thereby mooting the question of its compliance. Data on one or more of the indicators used in my analysis are not available for a small handful of other signatories, including Croatia, Estonia, Latvia, Luxembourg, and Slovenia, as well as the microstates of Monaco and Liechtenstein. My analysis therefore includes 32 countries.[6] In the year 2000, these 32 countries produced 99.1 percent of the total covered Annex I country carbon dioxide equivalent emissions.

Unit of Observation and Sample. My dataset includes one observation per country per year, from 1998 through 2006. The Kyoto Protocol was adopted in

[6] These countries are: Australia, Austria, Belarus, Belgium, Bulgaria, Canada, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, Lithuania, Netherlands, New Zealand, Norway, Poland, Portugal, Romania, Russian Federation, Slovakia, Spain, Sweden, Switzerland, Turkey, Ukraine, and the United Kingdom.

December of 1997, which defines the start point of my analysis. To be sure, the Protocol did not enter into force until 2005[7], eight years later, but given the long lag between policy reforms and carbon-reducing consequences of those reforms, it is reasonable to include the initial years after signing as indicative of compliance, because countries were required to make "demonstrable progress" by 2005[8] when the Protocol did enter into force, and could not otherwise expect to achieve their measurable commitments under the treaty. The end year of my analysis is 2006 simply because more recent data is not yet available. My total usable sample size is thus 287 country-years[9].

Dependent Variable. The measurement of compliance is the primary challenge of this analysis. In strict legal terms, the Annex I ratifiers of the Protocol are considered to be in compliance as long as (i) they make demonstrable progress by 2005 and (ii) their emissions meet the targets averaged over the five year period of 2008-2012[10]. It is hypothetically possible that all ratifiers might achieve their five year total commitments only in that final year, in which case, they would all be considered in compliance regardless of any over-quota emissions produced during the preceding years. However, demonstrable progress is required by 2005 and, in any event, measures taken by governments to reduce emissions take years to produce significant reductions, so it is

[7] Article 25 delayed entry into force until countries representing 55% of Annex 1 emissions had ratified.
[8] Article 3.2
[9] Conference of the Parties Serving as the Meeting of the Parties to the Kyoto Protocol. Page.11, paragraph 26. http://unfccc.int/resource/docs/2008/cmp4/eng/09r01.pdf
[10] Article 3.1

reasonable to assess yearly emission levels as valid indicators of ongoing compliance. This is the approach I take in my analysis.

Accordingly, for a given country in year *t*, the amount the country's emissions exceed its targets set forth under Annex B is as follows, expressed as a percent:

$$100 * \left(\frac{\text{Emissions}_t - \text{Emissions}_{1990}}{\text{Emissions}_{1990}}\right) - \text{Annex B Adjustment}$$

Annex B[11] defined country-specific deviations from the baseline year's emissions levels, which are embedded in this expression. For example, Iceland's cap was set 10% higher than its baseline amount. The benchmark levels for most countries were set to their 1990 total emissions, as in the above expression, but a few were allotted earlier reference years; for them, my analysis uses the assigned year instead of 1990. It is also important to note that Annex B gave a single value for the 15 (at that time) members of the European Union as a whole, as well as individually. As a special case, if the EU-15 as a whole meets the overall EU commitment, each member will be deemed to have met its commitment, regardless of individual failures[12]. The EU-15 members then negotiated specific quotas within that amount for each member[13]; my analysis uses these country-specific quantities for the EU-15 members. However, if the EU-15 fails to meet the overall commitment, then the failures will be determined on a member by member basis[14].

[11] Note: Turkey and Belarus are not part of Annex B. I therefore assumed an Annex B adjustment of 0% of their baseline carbon emissions.
[12] Article 4.1
[13] Article 24.2
[14] Article 4.6

The above expression gives the amount a country is over its target levels, in percent, for a given year. My variable *Compliance* is simply subtracts this expression from zero, to give it a matching interpretation to the concept. The sample average of *Compliance* is -4.1, with a standard deviation of 30.5; it ranges from -89.6 to 56.0.

It should be noted that this definition of *Compliance* would exclude carbon reductions from the flexible mechanisms of the Kyoto Protocol. This is because under the flexible mechanisms a country can get credit for carbon reductions that take place within the border of another state. This credit would not be reflected in the actual carbon emissions of the state and would consequently be missed using this model. However, this point is irrelevant because the first transactions regarding Kyoto emission units took place until 2007 and my model only encompasses the years 1998-2006. While this could provide a potential snag in the future it does not undermine this particular model.

Independent Variables

Diffusion. From my reading of the literature I hypothesized that the neighbor emulation would be the driving independent variable. I created a neighbor emulation variable by first dividing the countries up by geographic region. I created 6 regions: Northern Europe, Southern Europe, Eastern Europe, Western Europe, Non-Baltic Former Soviet Union and Non-European.

Table 1
Neighbor Countries by Region

Northern Europe Denmark, Estonia, Finland, Iceland, Ireland, Latvia, Lithuania, Norway, Sweden and the UK*	**Southern Europe** Croatia, Greece, Italy*, Portugal, Slovenia and Spain	**Western Europe** Austria, Belgium, France, Germany*, Liechtenstein, Luxembourg, Monaco, the Netherlands and Switzerland
Eastern Europe Bulgaria, Czech Republic, Hungary, Poland*, Romania and Slovakia	**Non-Baltic Former Soviet Union** Russian Federation*, Belarus and Ukraine	**Non-European** Australia, Canada, Japan, New Zealand and the United States*

*Largest carbon emitter in each region.

Northern, Southern, and Western Europe were divided according to the United Nations definitions. Eastern Europe was also decided by the UN definition with the exception of the Russian Federation, Belarus and Ukraine which I placed in the group Non-Baltic Former Soviet Union. I did this because I expected these countries to differ significantly politically from the rest of Eastern Europe. The last grouping is Non-European. Only countries in the same regional group are considered neighbors for the purposes of this variable, even if they border countries in other regions. The largest emitter in the region was declared the leader of that region. Countries were then matched with the leader in their region. I then compared the amount by which a leader country was exceeding its carbon emissions. The more this benchmark is exceeded by the less likely the neighbor countries were to comply. In order to create an index of neighbor emulation for the largest emitter states, I took the total emissions of the regional leaders and compared it to the total emissions permitted by the total of all the benchmarks for the regional leaders. This created an index which shows the effect of the compliance of the largest emitter countries on the compliance of a single leader country. Because of the way I constructed this variable a negative score indicates

compliance. The sample average for *Diffusion* is -6.2 with a standard deviation of 17.3 and a range from -36.5 to 19.3.

Fossil Fuel. The political power of the fossil fuel industry was another variable that might have a political impact on a country's compliance. In order to create this variable I used data from British Petroleum on the consumption of energy in each country. I added together the three types of fossil fuel energy (oil, coal and natural gas) and divided them by the total of all five types of energy listed (nuclear, hydroelectric, oil, coal and natural gas) and multiplied this number by 100 in order to generate the variable as a percent. My expectation was that a country with a higher consumption of fossil fuels would be more susceptible to lobbying by fossil fuel companies and that these companies would oppose the Kyoto Protocol because it would result in decreases in profits due to a decrease in consumption or an increase in costs to reduce carbon emissions. The *Fossil Fuel* variable mean is 79.5 with a standard deviation of 18.5 and a range from 29.8 to 100.

Green Parties. I expected the presence and strength of a green political party to cause a country to be more likely to comply. Green parties make environmental matters their main agenda and work actively through the political arena to reach their goals. For this reason I expect countries with larger green parties to be more compliant. I generated this variable by looking at parliamentary elections (in the lower house if there are two houses) and recording the percentage of the population that voted for the party in that given year. In order for a party to qualify as 'green' it needed to have

green or environment in the title. Most of the data came from the University of Bern and any missing data were filled in from Binghamton University's Election Results Archive. The mean for *Green* is 2.4 with a standard deviation of 3.3 and a range from 0 to 14.4.

Election Year. This variable indicates whether or not an election for the lower house of the legislature took place in a given year. This is a dichotomous factor coded as a dummy variable with a 1 indicating that an election took place that year and a 0 indicating that no such election took place. The mean for *Election Year* is .08 with a standard deviation of .27 and a range from 0 to 1.

Population. I included population in millions as my final political variable. I am using population as a reflection of the inertia of governments and their bureaucracies. It may be more difficult for a government coordinate larger numbers of actors (people, companies and government agencies) so a larger country has a larger government and therefore has greater difficulty implementing changes. This variable should negatively impact a government's ability to comply. The mean of *Population* is 29.0 with a standard deviation of 34.8 and a range from 0.27 to 146.3.

Controls

I have included two non-political variables as controls for my regression model. This is because economic factors play a very important in determining the emissions of greenhouse gases. However, my research aims to explain the political effects of

compliance with the Kyoto Protocol so it is important that I control for economic factors.

Total Growth. This variable reflects the absolute growth in percent of a country's GDP starting from the year 1990. I have decided to use 1990 as the benchmark for *Total Growth* because it is the benchmark year for emissions for the vast majority of the Annex I countries. The GDP is measured in constant US dollars based on the dollar's value in the year 2000. I expect this variable to generate greater consumption of fossil fuels and consequently negatively impact the likelihood of a country's compliance. The mean value is 25.9 with a standard deviation of 30.7 and a range from -59.0 to 172.

Per Capita Growth. This variable is designed to account for improvements in technology which can also impact carbon emissions. When a country grows and advances technologically it finds better and more efficient ways to use its resources. Thus a country might actually be able to reduce its carbon emissions by more efficiently using the energy it currently produces so that it gets more out of its current emissions. *Per Capita Growth* is the absolute growth in the economy since 1990 divided by the population of the country that specific year. The mean of *Per Capita Growth* is 19.7 with a standard deviation of 24.2 and a range from -57.5 to 124.1.

Table 2

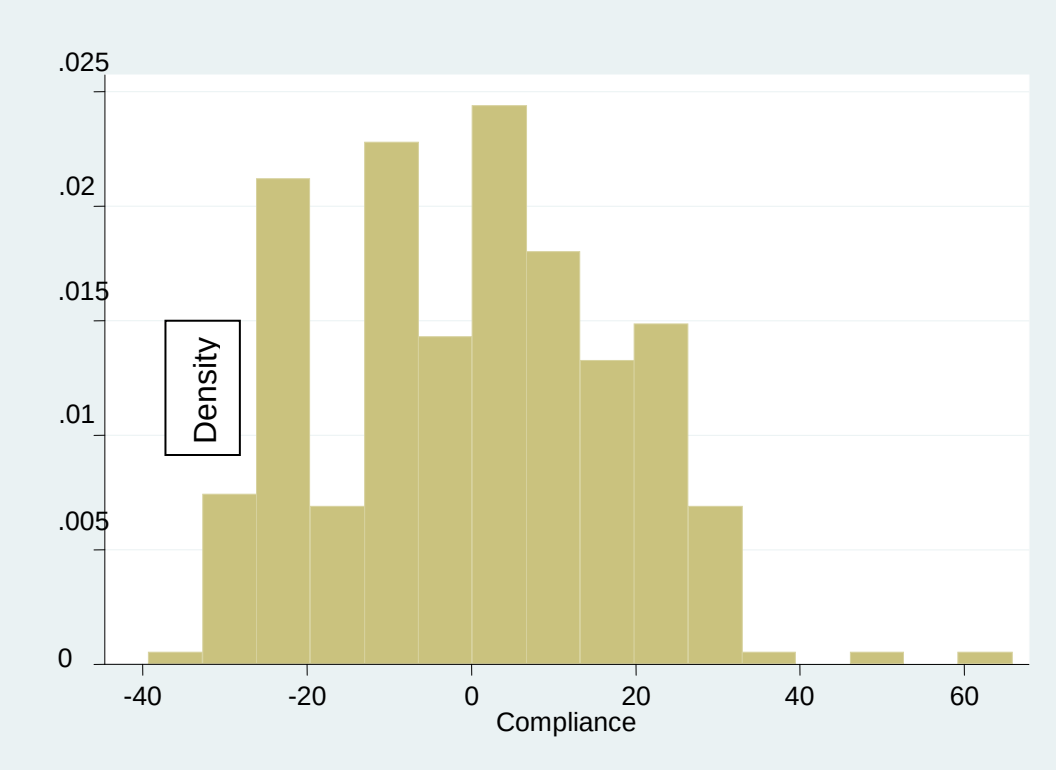
Descriptive Statistics

Variable	Mean	SD	Min	Max
Total Growth	25.9	30.7	-59.0	188
Per Capita Growth	19.7	24.2	-59.0	172
Diffusion	-6.17	17.3	-36.5	19.3
Fossil Fuel	79.5	18.5	30.0	100
Green	2.42	3.32	0	14.4
Election Year	0.08	0.27	0	1
Population	29.1	34.8	0.27	146

N = 287
Number of investigating countries = 32
Number of target countries = 39 (All Annex I ratifiers)
Years = 1998-2006
SD = standard deviation

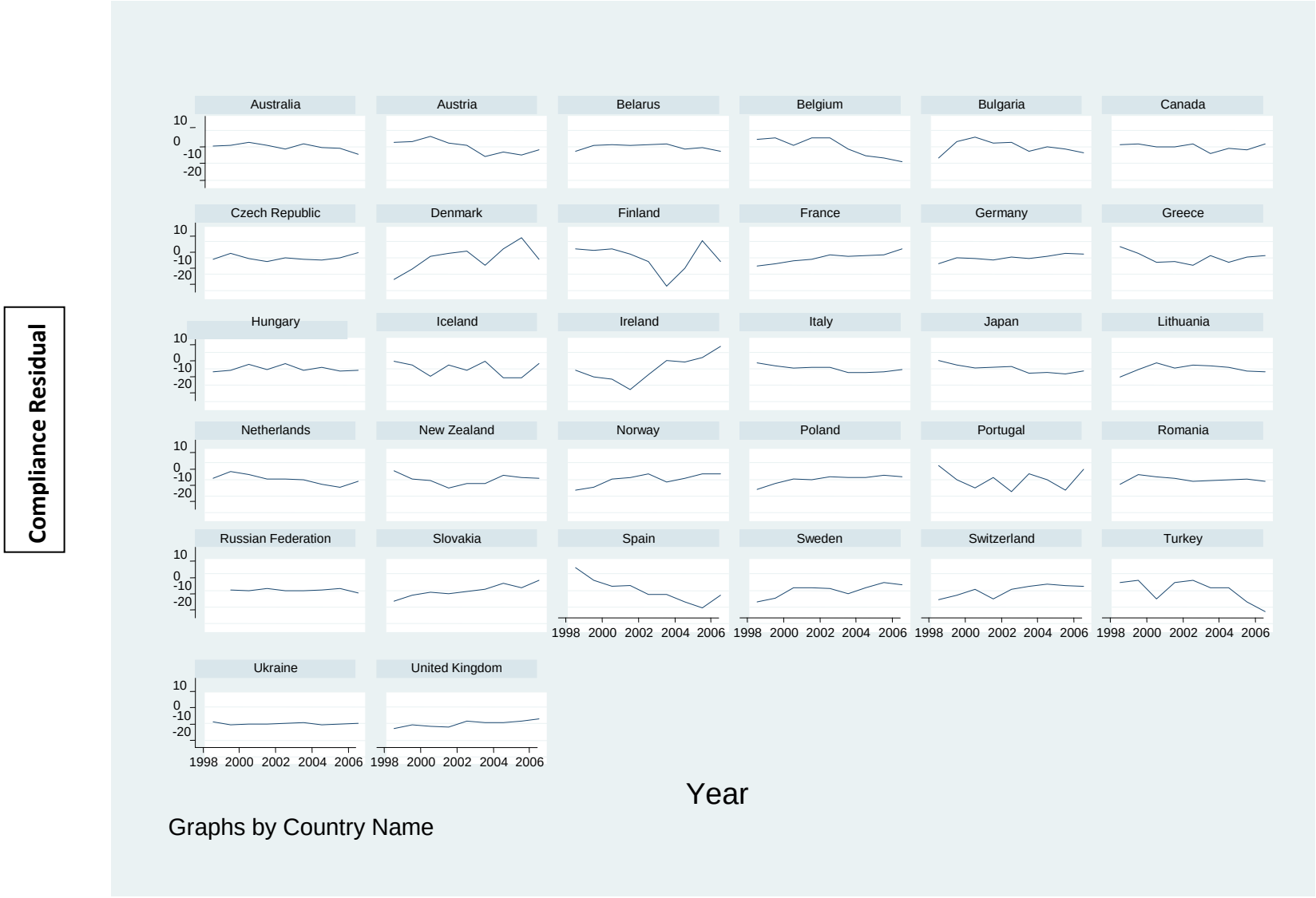
In order to isolate the potential impact of my independent variables, apart from the impact of growth, I constructed an adjusted compliance value. This adjusted value was the amount of compliance derived by running two regressions. The first regression included all the variables and controls in my model. The second just used my economic controls. I then took the residuals of my first model once the economic control regression was subtracted from it. I then graphed this value by individual country over the years in order to see trends caused by political factors (see graph 4). I have also included a graph of the total variance of *Compliance* due to political factors to show the aggregate variation of my sample (Graph 3).

Graph 3
Compliance Residuals for all States 1998-2008



Graph 4
Compliance Residuals Controlling for Growth

(See Graph on next page.)


Compliance Residual
Australia
Austria
Belarus
Belgium
Bulgaria
Canada
Czech Republic
Denmark
Finland
France
Germany
Greece
Hungary
Iceland
Ireland
Italy
Japan
Lithuania
Netherlands
New Zealand
Norway
Poland
Portugal
Romania
Russian Federation
Slovakia
Spain
Sweden
Switzerland
Turkey
Ukraine
United Kingdom
10
0
-10
-20
1998 2000 2002 2004 2006
Year
Graphs by Country Name

Graph 4 demonstrates that the influence of political factors once economic trends have been taken in to account. This gives a very interesting view as to which countries are complying and clearly it varies greatly from country to country. Some countries, for example France, Slovakia, Norway, Sweden and Ireland seem to be trending toward increasing compliance. While others are trending away from compliance, as is the case with Australia, Austria, Belgium and Turkey. Portugal and to a lesser extent Ireland seem to be a bit of a basket case as there doesn't seem to be any particular trend over the years. Somewhat surprising are the cases of Finland and Denmark which are trending toward compliance only to dip sharply away in the last few years. It is also surprising that Eastern Europe seems to be fitting in with the rest of the states being examined. I would have expected that once economic factors were accounted for that these states would be underachieving compared to their Western counterparts.

Analysis

Primary Model

TABLE 3
PRIMARY REGRESSION MODEL
REGRESSION OF COMPLIANCE WITH ABSORBING INDICATORS

	Model 1	
Dep. Var.: Compliance	*Coefficient*	*SE*
Constant	116**	16.0
Total Growth	-0.587**	0.080
Per Capita Growth	0.417**	0.089

Green	0.443*	0.178
Fossil Fuel	-0.839**	0.131
Population	-1.626**	0.416
Diffusion	-0.202	0.140
Election Year	-0.875	0.889
Number of observations	287	
Number of countries	32	
Years per country	9	
Years included	1998-2006	
F	62.8**	
Adj. R^2	0.989	

* 2-tailed $p < 0.05$; ** $p < 0.01$; 32 country-fixed effect variables are included in the model but are omitted from the table to save space.

This is the regression model I have chosen to work with for my research. Instead of using a simple regression I have decided to use linear regression with country-specific fixed effects. That is, the model includes a dummy variable for each country (outside of one country serving as a reference category). This is a conservative estimation approach, accounting for chronic differences across countries arising from unmodeled unobservable factors. The regression thus highlights the impact of the modeled covariates on changes over time within each country. (An F-test of the null hypothesis that all the country-specific fixed effects are equal to zero yields F=187.71, p<0.001, thus validating this modeling approach.) Further, this model explains 99% of the sample variance in *Compliance*, which adds to the model's credibility.

According to the model the control variables I selected worked as expected. *Economic Growth* was found to have a negative effect on a country's compliance as

shown by the negative coefficient associated with it. Furthermore, the p-value of *Economic Growth* is far below my .05 test for significance. This indicates that the variable is very significant. *Growth Per Capita* also had the expected affect of increasing compliance though by a smaller coefficient than *Economic Growth*. The p-value for *Per Capita Growth* is also .000 indicating that the variable is statistically significant.

How did my key hypotheses fare in the results? Overall, the findings show that popular environmental concerns, evidenced by larger shares of votes for green parties, increases compliance, while strong industry interests that might suffer financially from compliance tend to be associated with lower compliance. Additionally, countries with very large populations tend to have greater difficulty meeting their Kyoto goals. Compliance does not, however, appear robustly driven by regional diffusion, nor does it exhibit an electoral cycle. Consider, for instance, the results for the *Green Parties* variable shown in Table 3. *Green*'s coefficient estimate is 0.44, with a *p*-value of 0.013. The greater the share of seats in Parliament for "green" parties, the larger the country's cuts in emissions relative to its Kyoto commitment. How strong is the substantive impact of this variable? If I hold all other variables at their sample means and vary *Green* from 2.42 to 5.74 (which is one standard deviation away), the predicted value goes from -2.31 [-2.73,-1.88] to -0.833 [-2.07, 0.408].

The *Fossil Fuel* variable was found to be statistically significant, with a p-value of .000. The coefficient is -.84 indicating a strong negative impact on C*ompliance*. This shows that the stronger the fossil fuel industry in a given country, the less likely the

country is to comply with the Kyoto Protocol. The mean value of the sample for this variable is, 79.5 if adjusted by a single standard deviation in either direction is equal to 61 and 98 giving an effect on *Compliance* of 13.2 and -17.8 respectively. Furthermore, the confidence intervals for these adjustments [8.4, 18.0] and [-22.6, -13.0] do not come close to overlapping. This variable has a profound effect on the degree to which a country complies of fails to comply.

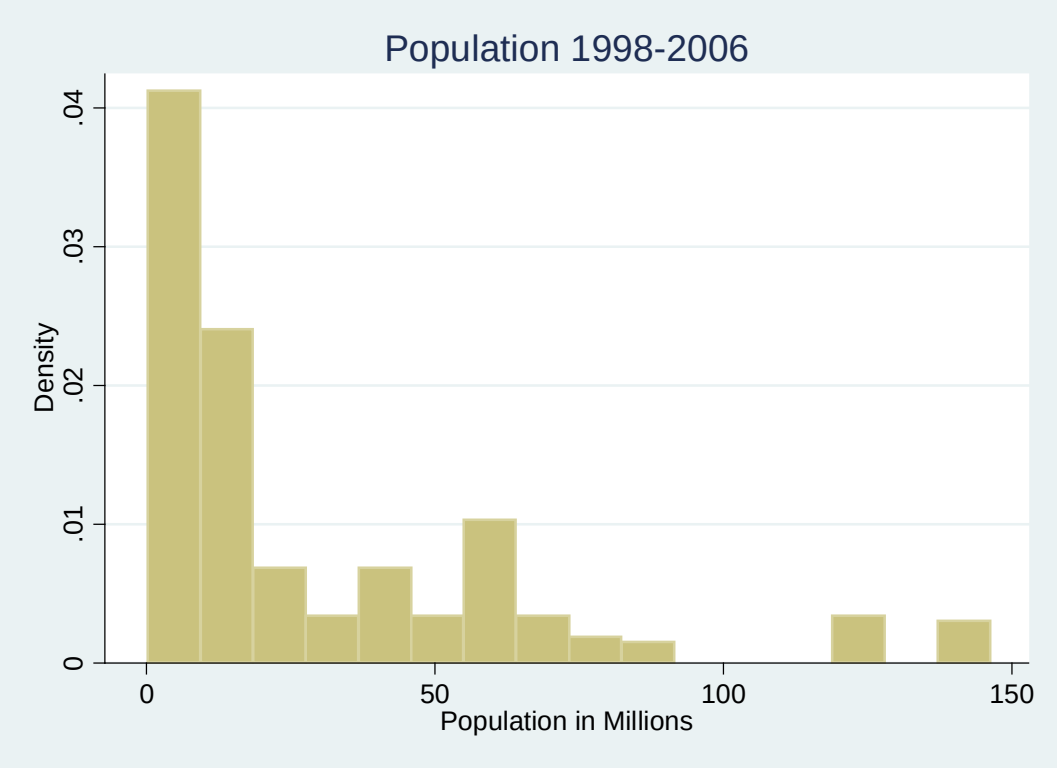
Election Year has a very high p-value (0.326) rendering it statistically insignificant and difficult to discern its impact on *Compliance*. Although the coefficient given by the model, -.88, is nominally pretty strongly against *Compliance*, the confidence interval ranges greatly from -2.63 to .88.

Diffusion, according to my model, most likely increases *Compliance*. However, we cannot be sure of its statistical significance because the p-value is .152 which is just more than a tenth over my significance test of .05. This is reflected in the fact that the confidence interval ranges from -.478 to .075 which includes both positive and negative impacts on *Compliance.* The t-value of -1.44 is not far off from being significant but the actual impact cannot be ascertained with a great enough degree of accuracy.

Population has a very strong negative impact on *Compliance*. The coefficient is -1.63 and is nearly double that of *Fossil Fuel*. The variable is also statistically significant because it has a p-value of .000 and a confidence interval of -2.45 to -.81. Clearly countries with larger populations are less likely to comply. The *Population* variable

appears to be skewed by a few countries with large populations because the mean is 29.0 while the median is only 10.3.

Graph 5
Population 1998-2006



Adjusting *Population* to the median value changes the overall effect of the model to 28.2 [12.8, 43.5], which is a dramatic increase in expected *Compliance*. This seems to indicate that a few larger countries might be struggling with *Compliance* but that the majority of countries are small enough that size is not inhibiting their ability to meet their Kyoto goals.

Because I aim to explain political influences I will isolate the effect of political factors as a whole by adjusting the model so that both *Total Growth* and *Per Capita*

Growth do not occur. This is done by adjusting the values for each to 0. Doing so yielded a positive coefficient for my linear prediction of *Compliance*. The new predicted value is 4.7 [3.44, 5.9] compared to the original -2.3. Because the 95% confidence interval only encompasses a positive set of numbers it is extremely likely that countries are moving toward *Compliance* once these economic factors have been accounted for. On the whole political factors seem to be moving countries toward *Compliance and* it is economic factors that are nullifying and reversing this effect. This possibly supports the idea that international treaties influence countries' behavior.

Alternate Models

Carbon Emissions Model

In order to test the robustness of my model I have run an alternate model using overall carbon emissions as the dependent variable, as opposed to relative to their Kyoto benchmarks.

TABLE 4
REGRESSION OF TOTAL CARBON EMISSIONS

	Model 2	
Dep. Var.: Total Carbon Emission	*Coefficient*	*SE*
Constant	49.1	52.4
Total Growth	0.19	0.27
Per Capita Growth	0.07	0.30
Green	-0.29	0.57
Fossil Fuel	1.20**	0.44
Population	4.70**	1.40

Diffusion	1.55**	0.47
Election Year	0.26	3.00
Number of observations	287	
Number of countries	32	
Years per country	9	
Years included	1998-2006	
F	16.0**	
Adj. R^2	0.999	

* 2-tailed $p < 0.05$; ** $p < 0.01$; 32 country-fixed effect variables are included in the model but are omitted from the table to save space.

Like my primary regression, this too uses country-specific fixed effects. This model has a p-value of .000 so it is statistically significant at any level. What is particularly interesting is that my economic controls are not considered significant to this model. The p-values for *Total Growth* and *Per Capita Growth* are 0.475 and 0.808 respectively, which are nowhere near the required value for statistical significance. This is to the contrary of what I expected which would be that the emissions are primarily driven by the economic situation of a specific country. However, this model seems to indicate that an increase *Per Capita Growth* causes an increase in carbon emissions, which is what I expected.

In this model *Green* has gone from being significant at the .05 level to having a p-value of 0.623. The coefficient of the variable is negative so it would seem that *Green* reduces emissions, which is the expected effect. However, the confidence interval for *Green* [-1.47, 0.88] spans both positive and negative numbers making it unclear as to

whether the strength of a green party actually reduces the amount of carbon emitted in a country.

Fossil Fuel on the other hand retains a significant impact on the model. The coefficient of 1.20 indicates that the greater the strength of the fossil fuel industry in a country the greater the amount of carbon emitted in total. In order to make sure that this relationship was not simply due to covariation; I used a correlation matrix and found that the variables only covaried by 0.161. This is a low value of correlation and illustrates that the relationship is not due to covariation.

Population was also a significant determinant of carbon emissions within a country. The coefficient is 4.70 which is far larger than any other coefficient in the model. It seems to follow that a country with a larger population would have a higher total carbon emission because a larger population requires greater energy to sustain it. Furthermore, these are the most advanced countries in the world so I would expect their per capita energy consumption not to vary much. However, I do not have any data on this to support such a claim. In order to make sure that this large coefficient was not simply due to covariation I used a correlation test. The result was a correlation of 0.934 which is an extremely high correlation.

Diffusion has also become significant under this new model; the p-value is .001. This means that if the leader of the region is over their carbon emissions quota a specific country within that region is more likely to emit a greater amount of carbon. Although, *diffusion* was not significant in the primary model it was not too far off. And in this new

model it has a highly significant p-value; so perhaps there is more credibility to the idea of neighbor diffusion than indicated in my primary model.

Yet again the *Election Year* variable proves to have no clear impact on the regression model. *Election Year* was assigned a p-value of 0.931 making it a basket-case among the variables. This is illustrated by the confidence interval which is [-5.63, 6.15].

US Model

The Unites States was the only Annex I country not to eventually ratify the Kyoto Protocol. Furthermore, while ratification is still theoretically possible[15] the US Senate has indicated that it never intends to ratify the treaty. However, in this model I will include the US in order to examine the any changes generated by the US.

TABLE 5
REGRESSION OF COMPLIANCE INCLUDING THE US

	Model 3	
Dep. Var.: Compliance	*Coefficient*	*SE*
Constant	71.0	12.7
Total Growth	0.19	0.27
Per Capita Growth	0.07	0.30
Green	-0.29	0.57
Fossil Fuel	1.20**	0.44
Population	4.70**	1.40
Diffusion	1.55**	0.47
Election Year	0.26	3.00
Number of observations	287	

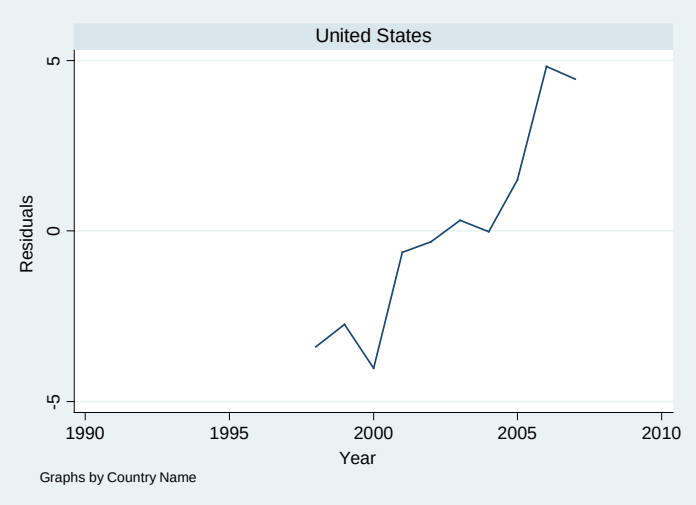
[15] Article 25.1

Number of countries	33
Years per country	9
Years included	1998-2006
F	16.0**
Adj. R^2	0.999

* 2-tailed $p < 0.05$; ** $p < 0.01$; 33 country-fixed effect variables are included in the model but are omitted from the table to save space.

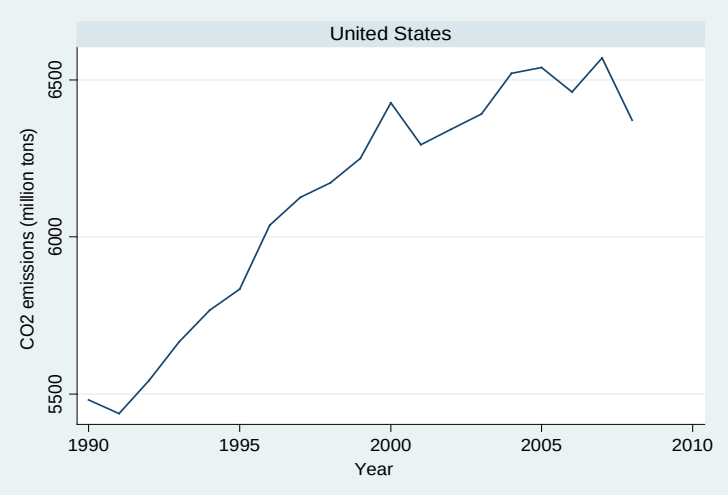
Because the US did not ratify the Kyoto Protocol it is not bound to the carbon emission reductions in the treaty. Therefore I would not expect the US to be in compliance with the Kyoto Protocol. To test this first I generated a *Compliance* variable for the US which used 1990 as the base year and a 7% reduction goal as is assigned to the US in Annex B. I then controlled for the *Compliance* attributable to economic factors leaving just the political ones. This is the exact same way I determined the two way graphs in Graph 4 so it is comparable (although it should be noticed the scale is smaller in the US graph).

Graph 6
United States Political Compliance
(Graph on next page.)



Unexpectedly this shows that political factors in the US are working toward *Compliance*. This does not mean that on the whole the US is succeeding in meeting its Kyoto goals and in fact total emissions are above its 1990 (its goal is 7% under this mark) level as illustrated in the graph below:

Graph 7
United States Carbon Dioxide Emissions



Diffusion Models

Because diffusion was what I hypothesized would be driving *Compliance* to the treaty I have come up with a number of alternative ways to measure it. Because of the similarities in all these different *Diffusion* models I am only presenting the information on *Diffusion* in the previous model. All other variables maintain the same effect on *Compliance* and the same level of significance in every model, with one exception to *Green* which will be noted later.

TABLE 6
SIGNIFICANCE OF DIFFERENT DIFFUSION VARIABLES

	Model 4		
Dep. Var.: Compliance	*Coefficient*	*SE*	*P-Value*
Diffusion [Primary Model] (6 Regions w/ Leaders)	-0.202	0.140	0.152
Diffusion 1.1 (5 Regions w/ Leaders)	-0.21	0.16	0.182
Diffusion 2.0 (6 Regions w/o Leaders)	-0.11	0.08	0.161
Diffusion 2.1 (5 Regions w/o Leaders)	-0.10	0.08	0.222
Diffusion 3.0 (6 Regions, Clean Energy)	-0.65	0.44	0.147
Diffusion 3.1 (5 Regions, Clean Energy)	-1.14*	0.49	0.021
Number of observations		287	
Number of countries		32	
Years per country		9	
Years included		1998-2006	

* 2-tailed $p < 0.05$; ** $p < 0.01$; 32 country-fixed effect variables are included in the model but are omitted from the table to save space.

This first model calculates *Diffusion* the same way as in my primary model with the exception that Eastern Europe and Non-Baltic Former Soviet Union have been

merged in to a single group with the Russian Federation as the designated leader. I have named this new variable *Diffusion 1.1.* *Diffusion 1.1* has a p-value of 0.182 which is slightly higher than in my primary model. This means that this way of measuring the variable yields a less significant result than the previous model and we cannot be sure of the effect of the variable on *Compliance*. There were no changes in significance or direction of effect in any of the variables as compared to the primary model.

The next two models measure diffusion slightly differently. *Diffusion 2.0* uses the same 6 country groupings used in my original diffusion variable. However, instead of taking cues from the largest emitter in the region *Diffusion 2.0* compares the total carbon emissions for all countries in a region compared to the total of their combined Kyoto goals. The more this total benchmark is exceeded the less likely a country is to comply, hence a negative coefficient is actually indicative of the variable increasing *Compliance*. *Diffusion 2.1* was generated through the same method as *Diffusion 2.0* but it merges Eastern Europe and Non-Baltic Former Soviet Union into a single region. The changes in both these models are only minor adjustments to the coefficients of the variables. The new diffusion coefficients are roughly one half of my primary model of *Diffusion* and *Diffusion 1.1*. However, the confidence intervals, [-0.27,0.04] & [-0.26, 0.06] respectively, overlap with the coefficients of previous models making it unclear whether or not there is a real difference in the degree to which *Compliance* is impacted .

This variable *Diffusion 3.0* created a diffusion index by taking the percent of energy used in a country coming from clean sources and weighting them by the carbon

emissions of that particular country. These weighted percents are aggregated into a single score for the region against which a particular country in that region is measured against. *Diffusion 3.1* was calculated the same way except that Eastern Europe and Non-Baltic Former Soviet Union are combined in to a single region.

Diffusion 3.1 has a p-value of 0.021 which is statistically significant at the .05 level and is the only significant measure of the impact of *Diffusion* of these 6 models. This means that in this model diffusion actually has a discernable effect on *Compliance* with a coefficient of -1.14 [-2.10, -1.72]. This actually lends statistically significant support to my hypothesis that *Diffusion* drives countries to *Comply* to international treaties. This is also the only one of the different diffusion models in which the *Green* variable is significant at the 0.01 level, the rest are only significant using .05 test for significance.

The reason this model, *Diffusion 3.1*, seems to have a clear effect when others do not, could be attributable to the fact that increased use of clean energy is a better signal of a country's resolve to reduce green house gasses. This would be because fossil fuels are by nature carbon based and therefore will always generate carbon emissions. So even if a country has found a way to lower its carbon footprint while using fossil fuels, it is still not as strong an indicator as an increased reliance on non-carbon based fuel sources like nuclear and hydroelectric.

Polity Model

Although regime was excluded from my primary model because there was little to no variance in type (democracy versus autocracy) I have decided to use the variable *Polity* in order to gauge to what extent are countries democratic. From my literature review I would expect countries with a higher polity score to be more likely to comply with the Kyoto Protocol. Polity scores are from Polity IV dataset and scores are missing for Iceland, which is why there are 9 fewer observations in this model.

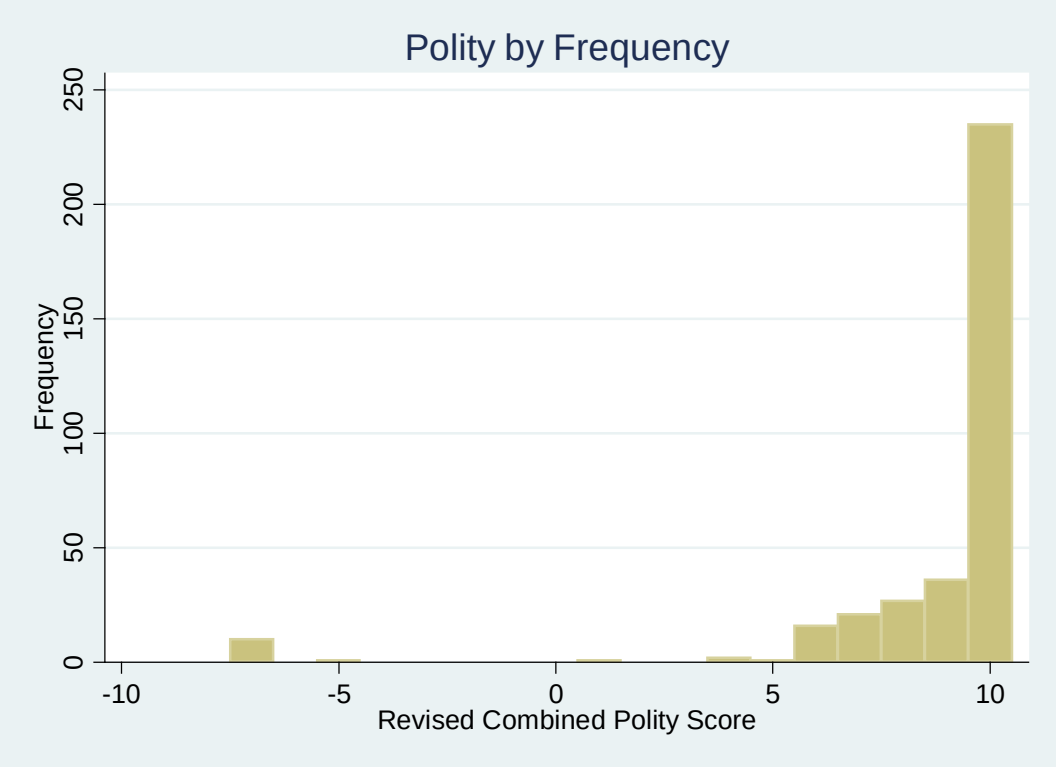
TABLE 7
REGRESSION OF COMPLIANCE INCLUDING POLITY

	Model 5	
Dep. Var.: Compliance	*Coefficient*	*SE*
Constant	123**	18.1
Total Growth	-0.52**	0.08
Per Capita Growth	0.35**	0.09
Green	0.34	0.18
Fossil Fuel	-0.87**	0.13
Diffusion	0.20	0.14
Election Year	-0.91	0.88
Population	-1.79**	0.42
Polity	0.25	0.84
Number of observations	278	
Number of countries	31	
Years per country	9	
Years included	1998-2006	
F	51.8**	
Adj. R^2	0.986	

* 2-tailed $p < 0.05$; ** $p < 0.01$; 31 country-fixed effect variables are included in the model but are omitted from the table to save space.

The introduction of the *Polity* variable changes the variables from my primary model very little. A slight increase in the p-value of *Green* leaves it statistically insignificant for this model. All the significant variables have the same general effect as do *Diffusion* and *Election Year* but we cannot be sure of the actual effect of those two variables. *Polity* has an extremely high p-value of 0.769 which means that the effect *Polity* has on *Compliance* cannot be determined.

Graph 8
Polity by Frequency



Looking at a graph of polity it is easy to see why we must discount P*olity.* There is almost no variance in *Polity* for this sample as the vast majority of countries scored the highest possible rating. *Polity* might be a better explanation if the developing world were also included, but for these developed countries it simply does not explain anything much.

Total GDP Model

According to (Weiss and Jacobson 1998) compliance requires sufficient regulatory bodies to support and enforce laws and regulations. However, the growth in environmental laws has not been matched by increases in bureaucracy. This has caused the existing bureaucracies to become overburdened and unable to perform their required function. For example the Council of the European Union (Council of Ministers) issued more environmental directives from 1989-1991 than in the previous 20 years. Furthermore, new directives are being added at a rate of roughly 100 per year, this on top of the 500 directives existing (Weiss and Jacobson 1998). In order to account for this explanation I have added the variable *Total GDP*. This variable is the GDP of each country in billions for a given year in constant year 2000 US dollars.

TABLE 8
REGRESSION OF COMPLIANCE INCLUDING TOTAL GDP

	Model 6	
Dep. Var.: Compliance	*Coefficient*	*SE*
Constant	115**	15.7
Total Growth	-0.58**	0.08
Per Capita Growth	0.41**	0.09
Green	0.45*	0.18
Fossil Fuel	-0.84**	0.13
Diffusion	-0.22	0.14
Election Year	-0.87	0.89
Population	-1.73**	0.44
Total GDP	0.005	0.006
Number of observations	287	
Number of countries	32	
Years per country	9	
Years included	1998-2006	
F	55.0**	
Adj. R^2	0.985	

* 2-tailed $p < 0.05$; ** $p < 0.01$; 32 country-fixed effect variables are included in the model but are omitted from the table to save space.

Contrary to Weiss and Jacobson a country's *Total GDP* does not have a significant impact on compliance according to my model. The p-value associated with *Total GDP* is 0.435 which makes it impossible to draw any conclusions about the variables effect on *Compliance*. However, this may be reconcilable due to the fact that even countries with good institutional capacity can lack this strength in the

environmental area. Germany's Ministry of the Environment does not have effective jurisdiction (Sbragia 1992:82 as cited in Weiss and Jacobson 1998).

Other than the addition of *Total GDP* as a variable in the model, this model is very similar to my primary model. The same variables are significant and have the same effect on *Compliance*. *Diffusion* moves slightly closer to statistical significance in this model as the p-value becomes 0.121 however the confidence interval [-0.50, 0.06] still leaves open the possibility that *Diffusion* could have a positive or negative on *Compliance*.

Election Year Excluded Model

For my last model I have decided to exclude election years because it has not had a significant impact on a single model I have used. This also allowed me to include the year 2007 which was excluded previously due to election year data being missing for that year.

TABLE 9
REGRESSION OF COMPLIANCE EXCLUDING ELECTION YEAR

	Model 7	
Dep. Var.: Compliance	*Coefficient*	*SE*
Constant	118**	114.5
Total Growth	-0.55**	0.07
Per Capita Growth	0.41**	0.08
Green	0.45*	0.18
Fossil Fuel	-0.78**	0.13
Diffusion	-0.28*	0.13

Population	-1.88**	0.39
Number of observations		2319???
Number of countries		32
Years per country		10
Years included		1998-2007
F		78.9**
Adj. R^2		0.987

* 2-tailed $p < 0.05$; ** $p < 0.01$; 31 country-fixed effect variables are included in the model but are omitted from the table to save space.

Excluding Election Year produces the best model yet. All the variables are significant at the .05 level, including *Diffusion*. In this model *Diffusion* has a p-value of 0.038 and a confidence interval of [-0.54, -0.01]. This illustrates that *Diffusion* actually increases the likelihood of *Compliance* as I hypothesized. Furthermore, all the variables are behaving in the manner expected based on my reading of the literature.

Conclusion

Despite the strong influence of economic factors I found that political factors do influence the degree to which states comply with the Kyoto Protocol. This is exciting because it is then possible to look at political aspects of a country and then predict whether or not it will comply. This could be applied to future climate change treaties and ideally make it possible to construct such international treaties in a way that will more effectively induce compliance of the member states. Furthermore, all of the variables that were statistically significant behaved in the manner I expected which

further supports the notion that it might be possible to predict *Compliance* based on political factors within a country.

Ultimately it seems *Diffusion* does not have a significant impact on states' compliance. In my primary model it is possible, perhaps even likely, that *Diffusion* causes *Compliance* in countries, however, there still exists the possibility that is does not. In fact, only in models '*Diffusion 3.1'* (Table 6) and '*Excluding Election Year'* (Table 9) did *Diffusion* attain a statistically significant impact. The '*Excluding Election Year'* model also seems to be the superior model of all the ones I examined because every variable is significant and the test itself is statistically significant. This lends some support to the idea that *Diffusion* increases *Compliance* however, it is still not a possible claim to make based on my results. When *Diffusion* did reach significance it acted in the way predicted in my hypothesis and literature review. This is exciting and further research may yield a definitive answer that yes, policy diffusion induces compliance.

In regards to my other political factors, the pull of dirty industry consistently and significantly detracted from a country's compliance to Kyoto. This is expected as it is costly for companies to research and develop new ways to created cleaner energy from fossil fuels. The precision of this variable could be improved if it quantified the actual political pull more effectively. Perhaps it could be quantified by looking at the amount of money spent lobbying congress or parliament by the fossil fuel industry.

The political impact of green parties was usually significant and increased a country's compliance with the Kyoto Protocol. This variable could be improved by

investigating the environmental platform of all political parties, not just the ones with green or environment in the name as in the case in my paper. However, that would be an extremely daunting task and difficult to quantify so maybe it should be approached through a case study of one or a few of the countries.

The population of a country influenced compliance, the greater the population the less likelihood of compliance. As I expected larger countries seem to have greater inertia when it comes to making, implementing and executing changes. This variable could be more precisely measured if it also took in to account government effectiveness. This might be measured by how long it takes an environmental law or regulation to come into effect or the relative power of the government making the law. Perhaps then an index could be created to measure how effective the government is at creating and implementing environmental regulations.

Lastly, the election cycle of a country seems to have no discernable impact on its compliance with the Kyoto Protocol. This variable never reached a significant level in my primary model or any of the alternative models put forth in the paper. I highly doubt there is an actual impact of the election cycle on compliance and inclusion of this variable in the future is not necessary.

It is true that I also found that economic factors play a very strong role in whether or not a country complies with an international treaty. And I also found that these economic factors behaved how I expected. Growth in general causes more greenhouse gases to be released making compliance more difficult and less likely

whereas improvement in technology enables countries to more easily comply because they can reduce their carbon intensity. Economic factors should not be overlooked in future attempts to predict compliance to international treaties like the Kyoto Protocol.

Further Research

My measurement of compliance is not perfect and some political scientists have measured compliance in other ways. Wettestad (2002 as cited in Ringquist and Kostadinova 2005) concluded that the Helsinki Protocol had caused compliance based on the significant policy changes in ratifying countries. So perhaps quantifying climate related policy changes would be a good measure of compliance.

Another, perhaps more convincing, method comes from Murdoch, Sandler and Sargent (1997 as cited in Ringquist and Kostadinova 2005) who used a spatial autoregressive model to determine that emission levels were indeed lower than what would have been expected if the Helsinki Protocol were absent. Helm and Sprinz (2000 as cited in Ringquist and Kostadinova 2005) also concluded the Helsinki Protocol to be effective. They went about this by reasoning from the counterfactual, as suggested by Simmons. First, they used experts to estimate levels of sulfur dioxide emission under complete compliance with the treaty and then under conditions of zero compliance with the treaty. They reasoned from the results that there was indeed a significant decrease in emissions due to the Helsinki Protocol.

There are a few variables that I would have liked to have tested and could possibly improve my model the future. One such variable would be federalism.

Countries with federalism spread the power of government over smaller decentralized units instead of a central authority. According to Weiss and Jacobsen this should make it more difficult to enact environmental rules because these smaller authorities are more limited in reach and power (Weiss and Jacobson 1998). It is also possible that the smaller subregions have special interests that could be contrary to the country as a whole. For example, if one region was rich in coal and generated a lot of carbon emissions it is not difficult to conceive it not wanting to curb the use of this resource. And in a federalist system there might be a lack of adequate power to force that region to comply.

Another variable also examined by Weiss and Jacobson is how strict the punishments are for not following environmental laws. The US has some of the strictest laws of any of the countries I examined. Environmental violations in the US can result in not just fines but serious prison time. Fines can also be huge, for example Exxon was levied a 100 million dollar fine for the *Exxon Valdez* spill and agreed in a civil settlement to pay 1.1 billion dollars to restore the damaged environment (Adler and Lord 1991 as cited in Weiss and Jacobson 1998). The UK, on the other hand, uses a different method. Instead of using strict laws and punishments the UK tries to be more cooperative and use mutual problem solving (Weiss and Jacobson). It would be worth investigating how these different approaches effect compliance.

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