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# The Continental Approach to Climate Change: An Analysis of the European Union's Emissions Trading System

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**Abstract**

The European Union's Emissions Trading System (ETS) stands as a model for managing a changing climate in a complicated international environment. As it enters its Phase III period of auctioning emissions permits, an understanding of players and their performance is essential to evaluating the success of the emissions market. Concerns that wealthy countries will purchase permits, rather than reduce their real emissions, have led to skepticism about the system's potential for success.

In this study, I examine ambition exhibited by countries in using less than maximum allowable levels of offsets to achieve Phase II reduction requirements. Using fuzzy-set Qualitative Comparative Analysis, I explore a number of variables including economic growth, Green Party representation, public opinion, and renewable energy investment to construct a model explaining variety in exhibited ambition among ETS countries. Results show that renewable energy and public opinion play the most significant role in explaining a country's use of offsets.

**Keywords**

climate change, political economy, environmental policy, emissions trading

## Introduction

Global climate change, the result of a century and a half of unchecked anthropogenic emissions from the burning of fossil fuels, threatens to drown out coastal civilizations, transform agricultural systems, and remove delicate species from the Earth. In order to prevent or postpone the worst of these impacts, the international community has engaged in a broad spectrum of activities and efforts to curb greenhouse gas (GHG) emissions. The United Nations Framework Convention on Climate Change (UNFCCC) established an international commitment to fight the rise in global temperatures that climate change threatened. The Kyoto Protocol to this convention, entered into force in 2007, presented countries charged with reducing their emissions with three flexible mechanisms to encourage cooperation in pursuing reductions (Hepburn, 2007). The European Union (EU) has taken advantage of these mechanisms, first using a bubble approach to calculate emissions reductions as a region, rather than by individual country, which enables individual countries to exceed or fall short of their required emissions reductions agreed to in the Kyoto Protocol. To further allow for flexibility, the EU established a carbon market with its Emissions Trading System (ETS). An understanding of this trading system, the influences on country behavior in the ETS, and the factors that contribute to ambition in various member countries of the market will be essential for the successful construction of a global carbon market.

Due to the system of differentiated responsibilities set up in the UNFCCC, which assigns responsibility to developed countries to lead the world in reducing GHG emissions, a market where permits to emit greenhouse gases are traded among countries is the most efficient way to reduce global emissions and institute a reasonable price on emissions. The price of efficiency may be the welfare of less wealthy countries that cannot afford to purchase carbon credits from others. With an understanding of what characteristics and behaviors set countries up for success in an emissions trading system, incentives and controls can be included in any future international climate regime that includes both developed and developing countries. If the dynamics of a European carbon market can be understood, important lessons can be applied to a future international market. A comprehensive study of the EU ETS can also reveal much about the changing nature of the European Union. The policy design of the ETS invests unprecedented decision making power in the European Commission (EC), the union's central bureaucracy, allowing the EC to approve and reject national allocation plans of emission permits and issue required changes to these plans (Ellerman, 2009).

In addition to applying lessons learned from the ETS abroad, a thorough understanding of the forces affecting country behavior through the end of the second phase of the EU carbon market will lay the groundwork for future analysis of an important next stage in the ETS beginning in 2013: the auctioning and trading of carbon units, dubbed European Union Allowances (EUAs). The ETS is administered in three phases. The first phase, spanning from 2005 to 2007, served as a pilot period, designed to ease firms and countries into the requirements set to enter force in 2008, when the second phase began. Phase II, the primary focus of this paper, is synchronized with the first commitment period of the Kyoto Protocol, ending in 2012 (European Commission, 2008). Phase II introduces the first cut in allowed emissions for the European Union as a bloc. The regional goal by 2012 under the protocol is to achieve an 8% reduction of 1990 emission levels (Hepburn, 2007). The second phase also imposes more regulatory and reporting requirements on firms in European countries, enabling them to prepare for the stringent requirements accompanying the auction period post-2012. Study now of Phase II results may provide guidance for how countries are likely to behave once trading begins under the market's third phase.

A primary concern among carbon trading critics is that wealthier countries will be able to afford to purchase offset credits from the developing world, and later EUAs from ambitious European countries, without actually making the investments and sacrifices required of other countries to reduce the GHG emissions resulting from economic activity. It is important to note that such a normative argument prioritizes non-market goods related to preventing significant climate change over the monetary expense of purchasing credits. Of further concern, the international emissions trading and offsets system creates a monetary disparity between reductions achieved in the European Union and offset credits generated in developing countries. Vasa (2012) shows a significant gap (estimated at €4.67 per unit) between the prices of Certified Emissions Reductions[1] (CERs) generated from Clean Development Mechanism[2] (CDM) projects in developing countries and EUAs representing emissions reductions within the EU. Such a difference between installing technology and implementing programs within EU countries and investing in similar projects in the developing world represent differences in labor and supply costs that will no longer be available to ETS participants at the conclusion of Phase II. Offsets from outside the EU are not permitted as replacements of measured reductions in the third phase of the ETS. Thus, a country's use of such offsets during Phase II may give some indication of its ambition to prepare for more difficult requirements effective 2013 (Pew Center on Global Climate Change, 2005).

## Economic Growth

In 2013, government behavior can hardly be analyzed—especially in Europe—without a consideration of economic influence on such state behavior. With the economic recession striking in 2008, Europe saw low economic growth for four years—nearly the entirety of the second phase of the ETS. GHG emissions have been shown to increase with economic growth (De Bruyn, van den Bergh, & Opschoor, 1998). A long recession that lasts the duration of the first Kyoto commitment period may allow countries to achieve their emissions reduction goals with less effort. If consumer demand falls with a recession, productivity among firms within countries is likely to fall, and pollution resulting from production may recede until the economy returns to full swing. Furthermore, those countries that experienced healthy economic growth during the second ETS phase are more likely to see their emissions grow, and will be under pressure to reduce emissions through offsets and other mechanisms rather than make efforts to reduce emissions and risk jeopardizing the economic growth the countries are enjoying. It is important to note significant differences in growth in emissions per dollar GDP growth between developing and industrialized countries (Bengochea-Marancho, Higon-Tamarit, & Martinez-Zarzoso, 2001). This difference is due to higher-energy industries developing in less wealthy countries compared to technological and information-based developments in advanced economies. Such diversity in the impacts of economic growth requires a tailored approach that allows each country to be evaluated individually. Other economic factors affecting emissions growth include fuel

1 A Certified Emissions Reduction is equivalent to reducing 1 metric ton of Carbon Dioxide emissions and can be applied to a national inventory of greenhouse gas emissions under the Kyoto Protocol regime.

2 One of two (along with the Joint Implementation mechanism) offset vehicles included in the Kyoto Protocol to the UN Framework Convention on Climate Change. These vehicles allow countries to count investments outside of their borders against emissions generated from within and are intended to incentivize investment in the developing world.

mix, political influence of industrial leaders, and export profile, to name a few. For example, a 2002 study found that Germany and the United Kingdom had much less room to reduce emissions than the Netherlands—the latter boasts double the percentage of electricity derived from renewable energy as the former (Hamilton & Turton, 2002).

The connection between a country's economic profile and its propensity to reduce emissions does not necessarily follow traditional environmental economic theories. Further, the fluctuations of the global economy offer little long-term explanation for variation among developed countries in emissions. Traditional thoughts behind environmental pollution falling as income rises do not seem to apply for climate change. The environmental Kuznets curve theory holds that there is an inverted-U shaped curve portraying the relationship between income and pollution, where pollution rises then falls as national income increases (Stern, Common, & Barbier, 1996). The theory holds particularly strongly for local, visible pollutants, such as contaminated water or discolored air. Undetectable carbon emissions create less of a reaction when they escape a car muffler or industrial stack. De Bruyn, van den Bergh, & Opschoor (1998) find that CO2 grows with income, rather than tapering off after a certain level is reached. Although many rich countries are leaders in low and reduced emissions, the global dispersion of emissions may create a weaker incentive for citizens to demand higher standards of environmental protection from their governments. Schellenberger & Nordhaus (2004) attribute this larger structural failure in the environmental movement in part to a cognitive dissonance between the problems facing our environment and the solutions on hand to solve them, specifically holding that steps to reduce pollution may impact comfortable lifestyles. When an environmental policy is framed in economic terms, voters see a price they are unwilling to pay in the rich world, especially if the problem is long-term climate change rather than a more immediate threat of radiation or toxic drinking water.

With the potential for reduced or decelerated emissions during an economic recession, we may expect to see reduced ambition during times of economic growth. However, if the environmental Kuznets curve requires a much higher income turning point than other forms of pollution, other explanations will be necessary for state action complying with climate change agreements and reducing emissions within national borders. In Table 1, improvements in carbon intensity are seen in most countries (a negative value represents a reduction in carbon emissions per dollar), confirming a study of United States CO2 environmental Kuznets curves (EKCs) that found that an income turning point may exist, but at a much higher level than usual for an EKC (Aldy, 2005). Table 1 provides levels of carbon intensity for countries in the ETS at the beginning of the first phase of the emissions reduction regime and in 2011 after the recent recession and near the end of Phase II of the ETS. Largely, these countries have seen a negative change in their carbon intensity. Without regular economic growth, this could be a positive sign for emissions reductions.

Related measures of a country's economy may also affect emissions, especially sources of energy and electricity. Economies tied to significant fossil-fuel resources are less likely to display strong ambition to curtail their emissions further as economic costs of reducing emissions from energy use may be substantially high. Alternatively, countries with higher renewable energy use may find an easier path to reduction as they have 1) indicated ambition to make significant economic changes in the pursuit of environmental benefits from reducing GHG emissions and 2) already incurred the costs of switching from carbon-intensive fossil fuels to clean sources of energy. Particularly of interest, long-term investment in renewable energy sources may indicate a government's permanent commitment to environmental objectives.

**Table 1. Carbon Intensity From 2005 to 2011 in ETS Countries**

| Country | Carbon Intensity in 2005 | Carbon Intensity in 2011 | Change |
|---|---|---|---|
| Germany | .30706 | .24748 | –.05958 |
| Spain | .33599 | .26839 | –.05958 |
| Lithuania | .59998 | .55215 | –.04782 |
| Denmark | .20133 | .17882 | –.02251 |
| Italy | .26561 | .22889 | –.03672 |
| France | .1941 | .16721 | –.02689 |
| Norway | .139 | .145 | .006 |
| Bulgaria | 1.92191 | 1.65549 | –.02589 |
| Malta | .515569 | 1.00341 | .48772 |
| Netherlands | .42075 | .36335 | –.0574 |
| Austria | .25439 | .19992 | –.05447 |
| Sweden | .15551 | .12837 | –.02714 |
| Ireland | .22087 | .18738 | –.03349 |
| Cyprus | .52088 | .49959 | –.02129 |
| Czech Republic | .75449 | .63856 | –.11593 |
| Luxembourg | .33547 | .26913 | –.06634 |
| Finland | .26546 | .25436 | –.0111 |
| Romania | .98007 | .75631 | –.22376 |
| Portugal | .3459 | .28138 | –.06452 |
| Latvia | .5403 | .52563 | –.01467 |
| Poland | .94629 | .77494 | –.17135 |
| Slovenia | .4787 | .40176 | –.07694 |
| Hungary | .54049 | .44711 | –.09338 |
| Greece | .43515 | .38386 | –.05129 |
| Belgium | .40003 | .32137 | –.07866 |
| United Kingdom | .25576 | .21138 | –.04438 |
| Slovakia | .827779 | .56283 | –.26496 |
| Estonia | 1.36387 | 1.6569 | .00182 |

Source: U.S. Energy Information Administration (2011)

Because of the economic growth/carbon emissions positive relationship observed by De Bruyn, van den Bergh, & Opschoor (1998) a period of slow or no economic growth may lead to lower than expected growth in carbon emissions. The global recession starting in 2008 may therefore produce low growth in emissions without the usual requisite structural changes in industrial sectors (technological advances, fuel switching) necessary for permanent reductions. This could bode poorly for country performance in Phase III of the

ETS and is important to track as an explanation for observed measures of ambition. Long-term economic investment, such as that required for renewable energy use, reflects both a recession-proof reduction in (or avoidance of) GHG emissions and a political commitment to supporting a clean economy. Such investments may prove powerful in explaining ambition in the ETS.

### Political Institutions

Immergut (1990) demonstrates how European political institutions can shape policy outcomes in specific areas where heavy non-governmental influence exists, such as health-care regulation. The healthcare market features such entrenched interests as physicians and insurers that can exert great influence over policymakers, while environmental regulations enjoy the support of a less wealthy constituency. The non-profit organizations and interest groups driving environmental policy and climate action are substantially weaker financially and potentially less represented in major political parties in Western democracies than healthcare special interests. Further, business groups face steep costs from emissions abatement policies and may use their influence to stop ambitious legislation. The political system of a country may allow for various levels of engagement by these interest groups and explain differences in policy contributing to ambition.

Comparative politics literature holds that majoritarian electoral systems yield centrist policies geared to attract the median voter in a population while proportional representation electoral systems produce policies attractive to a smaller party constituency (Wessels, 1999). The incentives for legislatures to produce policies convenient to groups of social groups with distinct interests (i.e. distribution of income to poor, strong action against climate change for an environmental lobby), are increased when the electoral system allows for multiple parties with specific constituencies (Austen-Smith, 2000).

If electoral results are demonstrative of a legislature's incentives to produce a certain policy outcome, then the proportion of a country's legislative seats held by parties with explicit commitments to environmental action may serve as a strong indicator of influence on a country's climate action ambition. Countries with high Green Party representation, such as Germany, should see strong commitments to environmental and climate action. Countries with no Green Party representation may not have an advocate for environmental initiatives in the legislature and therefore see relatively little ambition for costly climate action. Even countries with small Green Party representation have a voice in parliament supporting environmental legislation and influencing the legislative agenda. Small parties can be essential partners for mainstream parties looking to form coalition governments, allowing opportunity for political adoption of emissions abatement programs.

### Public Opinion

While political and economic factors may help provide predictors for climate ambition, public opinion can help identify an underlying political culture supportive (or not) of ambitious emissions reductions. Across Europe, opinions about climate change generally lean toward action. One in five Europeans see climate change as the single most serious problem facing the world, second only to "poverty, hunger and lack of drinking water" (European Commission 2011, p. 5). It is notable that climate change received significant support over "the economic situation" in the midst of a regional financial crisis and over "international terrorism" as some member countries are engaged in at least three military engagements.

In general, younger respondents feel more strongly about taking action on climate change.

While the importance of climate change in public opinion has decreased in recent decades across Europe, significant variation in opinions towards the impacts of rising emissions may help identify why certain countries have strong ambition and others produce a more lackluster response. With the prioritization of climate at 20% on average in the entire region, Luxembourg leads the pack with 34% of its citizens surveyed identifying climate change as the "single most serious problem facing the world as a whole" (European Commission, 2011). Portugal ranks last with only 7% of its citizens prioritizing climate change above other issues. The variance among public opinion in the countries participating in the ETS may help explain why some exert more ambition than others. A rational model of political action would hold that democratically elected policymakers will respond to voter concern over climate change. Therefore, we can expect countries with high public concern over climate change to exhibit significant ambition for reducing GHG emissions. Countries with weak public support may have no incentive to bear the costs of acting beyond what is required of them by the European Commission, especially if costs of requirements in Phase III can be borne by a successive government or blamed on the EU itself.

Comparative analysis can provide useful conclusions by comparing the relative contribution of each of these variables to an outcome measure of emissions reduction ambition while avoiding the large-n requirements of statistical analysis. Qualitative Comparative Analysis is a tool that can be used to identify separate paths to an outcome in addition to specific necessary requirements for the presence of climate ambition.

## Research Design/Method

Conducting policy analysis in studies restricted to members of the European Union is complicated by the small number of countries qualifying for analysis. The EU consists of 27 countries, and the ETS includes the members of the EU and 4 others: the neighboring countries of Croatia, Iceland, Norway, and Lichtenstein. Because of this small number of cases to test, statistical analysis can prove inaccurate or difficult to conduct.

In order to determine the relationship between various causes and a measure of ambition to take permanent action to reduce GHG emissions in EU countries, I will employ a Qualitative Comparative Analysis of economic, social, and political variables on individual countries' ambition measurements under the EU ETS. The set-theoretic approach is preferred in that it allows analysis of both necessary and sufficient conditions for a desired outcome. As presented by Schneider & Wagemann (2012), Qualitative Comparative Analysis (QCA) allows for an interpretation of ETS member actions explained by variations in economic conditions, political institutions, and public opinion towards climate change and environmental policy. QCA allows for individual cases (countries) to be evaluated based on the respective variables that produce a similar outcome in each case. By using fuzzy set QCA (fsQCA), which measures variables on a range from 0 to 1, this method allows for broad range in each variable to reveal further information about the causes of an outcome in the data set. QCA can identify the causal variables for climate action ambition, as well as any causal combinations that lead to an outcome of climate ambition when present concurrently.

Fuzzy set QCA allows for the testing of necessary and sufficient conditions for a given outcome. Using outcome Y as a measure of state action to reduce GHG emissions, fsQCA can determine a set of causes that will lead to substantial effort. As discussed above, economic, political, and social variables factor in to a country's commitment to reduce carbon emissions. In the ETS, every country is governed under the same rules, allowing for broad conclusions about conditions to be drawn. In QCA, necessary conditions are those requirements that must be met in order for an outcome to be achieved. In other words, the outcome Y must be a subset of the necessary condition X. In this study, public opinion is essential for any government action. Further, actual reductions and offset purchases are carried out by individual firms, subject to rules set by and with the assistance of national governments. This may enable firm behavior to be responsive to consumer opinions on GHG emissions and efforts to reduce pollution. Therefore, I hypothesize that public support for climate change is a necessary condition for any measure of ambition, or:

*$H_1$: Public Support for Climate Action is a <u>Necessary Condition</u> for Y =Climate Ambition.*

In contrast, sufficient conditions are subsets of the outcome. In other words sufficient conditions A, B, and C may all lead to outcome Y separately, or in any combination (AB, AC, BC, ABC). Also, the absence, rather than presence, of one of these variables may produce a positive measure of the outcome, denoted as such: ~A. As mentioned above, low economic growth can allow for lower costs of climate action. Also, higher renewable energy use lowers the cost of reducing fossil fuel usage and signifies existing ambition in national governments to address climate change challenges. I propose that an absence of growth and a presence of renewable energy ambition will produce a measure of climate ambition jointly, or:

*$H_2$: ~Economic Growth AND Renewable Energy Use are, together, <u>sufficient</u> conditions for Y =Climate Ambition.*

Because parliamentary representation is a reflective of electoral success and therefore an expression of public opinion, widespread support for climate action in Europe should manifest through strong Green Party representation in national parliaments. Thus, the percentage of parliamentary seats held by Green Party members of parliament (MPs) should prove a sufficient condition for climate ambition.

*$H_3$: Strong Green Party Representation is a <u>sufficient</u> condition for Y =Climate Ambition*

In order to test these hypotheses, I will first define the variables for the outcome and conditions listed above. Data for these points must be calibrated on a 0 to 1 scale in order to be analyzed via fuzzy set analysis. Using fs/QCA software (Ragin, Drass, & Davey, 2006), I will test for necessary and sufficient conditions for a defined outcome representing climate ambition. This analysis will reveal the strength of relationships on the outcome, allowing a test of the above hypotheses and produce tracks of combination policies that lead to climate ambition.

## Data

I have collected data for 28 countries (EU 27 + Norway). Lichtenstein, Croatia, and Iceland are also participants in the ETS, but there was no data available for the causal variables I examined for Lichtenstein, and Iceland and Croatia did not participate in the second phase of the ETS, lacking data for the outcome variable in my study. Data examined includes purchases of offsets—including Clean Development Mechanism and Joint Implementation projects, economic growth, Green Party representation in national parliaments, percentage of energy mix derived from renewable energy sources, percent of public viewing climate change as a priority, and average seriousness a country's citizens assign to climate change. Offset use was found from the European Commission's Union Registry for the Emissions Trading System (European Commission, 2013). Economic growth data is from The World Bank (World Bank, 2013). Green Party representation in national parliaments was provided by the European Green Party (European Green Party, 2013). Renewable energy use was found in the United States Central Intelligence Agency's World Factbook (Central Intelligence Agency, 2009). Finally, public opinion on climate change was found in the 2011 Special Eurobarometer on Climate Change (European Commission, 2011).

The outcome (Y) represents the residual volume of allowed offsets for each country in the Emissions Trading System, derived from subtracting the total amount of Certified Emissions Reductions and Emissions Reductions Units (generated from projects sponsored via the Clean Development Mechanism and Joint Implementation vehicles of the Kyoto protocol, respectively) from the amount of emissions allowed to be offset with purchased units under each country's National Allocation Plan for the second phase of the ETS. The Phase II National Allocation Plans specified a level of emissions that could be reduced through offset purchases for each country with the following formula:

*Offset Limit = (Highest Emissions Level of 1990, 2004, 2010 – Kyoto Emissions Target) * 0.5*

where a country's target emissions level after reductions under the Kyoto Protocol to the United Nations Framework Convention on Climate Change is subtracted from the country's highest level of emissions in either 1990, 2004, or 2010, which yields the total amount of emissions reductions the country must achieve (Vasa, 2012). The ETS requires that half of these reductions be achieved through real reductions in emissions, although the 1990 emissions ceiling allows for a high amount of flexibility in calculating room to reduce emissions. A collection of these values for ETS members is shown in Table 2 (next page).

Ambition of each member state (Y) during Phase II can be measured with the following formula:

*Y = Offset Limit – Percent of reductions achieved via offset purchases*

The percent of reductions achieved through offset purchases is derived by dividing the sum of emissions units certified by national registries for use in the ETS by the total allocation of units each country is assigned:

*Percent of reductions from offsets = ([Country] Certified Emissions Reductions from CDM projects + [Country] Emissions Reductions Units from JI projects) / Total Allocated CO2 Emissions for [Country] in ETS Phase II*

While the Offset Limits for individual countries participating in the ETS are derived from technical data on emissions—affected by, but not a direct result of, political causes, the spread between actual offsets purchased and the Offset Limit can be seen as an indicator of ambition within countries to reduce greenhouse gas emissions. If the Offset-Limit/Purchased-Offsets spread represents climate action ambition in European countries, then the use of Qualitative Comparative Analysis can identify contributing factors to the variance in ambition among countries.

**Table 2. ETS Allowances and Offset Rules, Phase II**

| Country | ETS Phase II Allocated CO2 Allowances (million tons per year) | National Maximum Percentage of Allowances Achieved From Offset Purchases | Ambition in percent, Measured by Difference Between Offsets Purchased and National Limit |
|---|---|---|---|
| Germany | 451.5 | 22 | 13 |
| Spain | 152.2 | 20.6 | 9.25 |
| Lithuania | 8.6 | 20 | 7.29 |
| Denmark | 24.5 | 17.01 | 12.38 |
| Italy | 201.6 | 14.989 | 8.92 |
| France | 132 | 13.5 | 5.45 |
| Norway | 15 | 13 | 2.38 |
| Bulgaria | 42.3 | 12.5 | 4.40 |
| Malta | 2.1 | 10 | 10.00 |
| Netherlands | 86.3 | 10 | 7.60 |
| Austria | 32.3 | 10 | 6.40 |
| Sweden | 22.4 | 10 | 6.17 |
| Ireland | 22.3 | 10 | 5.49 |
| Cyprus | 5.2 | 10 | 5.40 |
| Czech Republic | 86.7 | 10 | 5.26 |
| Luxembourg | 2.5 | 10 | 4.60 |
| Finland | 37.6 | 10 | 4.52 |
| Romania | 73.2 | 10 | 4.18 |
| Portugal | 34.8 | 10 | 4.18 |
| Latvia | 3.4 | 10 | 3.40 |
| Poland | 205.7 | 10 | 3.23 |
| Slovenia | 8.3 | 10 | 2.07 |
| Hungary | 19.5 | 10 | 1.33 |
| Greece | 68.3 | 9 | 3.81 |
| Belgium | 58 | 8.4437 | 4.54 |
| United Kingdom | 245.6 | 8 | 4.59 |
| Slovakia | 32.5 | 7 | 0.20 |
| Estonia | 11.8 | 0 | -0.33 |

Source: European Commission (2008)

In calibrating fuzzy set numbers, quantitative measures of variables are converted to represent variation in each variable on a scale of 0.0 to 1.0 (Schneider & Wagemann 2012). On such a scale, any calibrated value below 0.5 is considered to not meet the membership requirement for the variable. Likewise, any value above 0.5 is considered to have fulfilled the requirement for membership for that specific variable. These membership requirements are set such that an "in" or "out" determination will separate data from each other. A value of exactly 0.5 represents the dividing line for determining if a variable is present or not. For example, significant Green Party representation in parliament can be represented by calibrated values between 0.5 and 1.0. Therefore, any country with between 5 and 15% of seats in parliament held by Green Party members would be considered to have significant representation and receive calibrated scores reflecting the case's (or country's) membership in the group "significant Green Party representation." If all countries displaying climate ambition belong in this group, then it would be considered a necessary condition. If all countries that received positive membership values for both significant Green Party representation and "large annual economic growth" (measured as larger than 2% per year) exhibited strong climate ambition, then that combination could be considered a sufficient condition for the outcome.

Table 3 includes "parameters" that explain the criteria for determining membership for each variable. Largely, these parameters are set by a nature of the data available, with the top parameters corresponding to the highest values available for each variable, the bottom parameters representing a baseline (usually 0) or the lowest value in a set. The 0.5 turning point parameter is set by theory or as a product of the data. For example, a score of 5 on the 1-10 point scale of climate seriousness in public opinion represents the actual point on the scale respondents were given to indicate whether or not they considered climate change a serious issue. Other categories, such as Green Party representation and Renewable Energy investment may represent significance at levels lower than half of the range of the data. For these, a middle parameter was set that would separate negligible values from relevant data.

**Table 3. Parameters for Fuzzy Set Analysis**

| Variable | Top Parameter | 0.5 Turning Point | Bottom Parameter |
|---|---|---|---|
| Y, outcome | 15 % | 5% | 0% |
| Annual growth, avg 2005-2011 | 4.5 % | 2% | -0.1% |
| Green Party Representation, % of seats in parliament | 15% | 5% | 0% |
| Renewable Energy, % of total energy mix | 35% | 10% | 0% |
| Climate Change as Top Priority, % of Public | 30% | 10% | 0% |
| Climate Change as Serious Problem, 1-10 scale | 10 | 5 | 0 |

Analysis produced by QCA can be analyzed by two descriptive values representing completeness and accuracy of the relationships revealed by the methodology, known as coverage and consistency, respectively. These values have slightly different meanings for necessary and sufficient conditions. For sufficient conditions, the consistency score represents the percent of data meeting the sufficient condition(s) (X) that leads to the outcome (Y) (Schneider & Wagemann, 2012). If 80% of countries with "significant Green Party representation" exhibit high climate ambition, represented by a calibrated score of 0.5-1.0 for the variable "spread", then the consistency score for Green Party representation as a sufficient condition would be 0.8. Coverage indicates the percent of total cases that fit in a sufficient condition. For example, if 12 countries exhibited strong climate ambition via the calibrated scale, and 4 of those cases fit the Green Party sufficient condition, then the coverage score would be 4 out of 12, or 0.33.

Necessary conditions require that all cases positive for the outcome meet their requirements, so no coverage score is necessary. The consistency score for a necessary condition represents how many cases that are not positive for the outcome are positive for the necessary condition. If "Renewable Energy Investment" is a necessary condition for climate ambition, all 12 cases are positive for it, but 3 additional cases indicate Renewable Energy Investment without any climate ambition, then the consistency score would be 12 out of 15, or 0.8. Low consistency scores may indicate additional variables not present in the QCA.

Before conducting full QCA, we can verify that it is the best fit methodology to use for a small-n data set by conducting a correlation test for all variables against the outcome measure. The correlation values displayed in Table 4 indicate that no one variable presents a strong correlation for climate ambition. Y=Climate Ambition refers to the difference (spread) between allowed and actually purchased offsets. AGDP represents the average growth in Gross Domestic Product between 2005 and 2011. GMPS is the percent of seats in national parliaments held by members of the Green Party. ERENEW represents the percent of electricity in a country generated from renewable sources. CCPRI is the percent of the public that holds climate change as a priority in the world today, and CCSER is the score of how serious a national population perceives climate change.

**Table 4. Correlation Matrix**

| | Y=Climate Ambition | AGDP | GMPS | ERENEW | CCPRI | CCSER |
|---|---|---|---|---|---|---|
| Y=Climate Ambition | 1.0000 | – | – | – | – | – |
| AGDP | -0.2822 | 1.0000 | – | – | – | – |
| GMPS | 0.0619 | -0.0026 | 1.0000 | – | – | – |
| ERENEW | 0.5389 | -0.5441 | -0.0001 | 1.0000 | – | – |
| CCPRI | 0.4362 | 0.1460 | 0.2690 | 0.0302 | 1.0000 | – |
| CCSER | -0.0331 | -0.0121 | -0.1900 | -0.2275 | -0.0418 | 1.0000 |

## Results

After calibrating each variable, the data must be tested for necessary conditions for outcome Y. In running each variable through a test for necessity, only public opinion of climate change as a serious problem was revealed to be a necessary condition. The variable CCSER, represented in the last row of Table 3, was considered a necessary condition for outcome Y with 97.95% consistency (high confidence). In contrast, ~AGDP, or absence of average annual economic growth, was considered necessary for Y with 81.89% consistency. The absence of economic growth may indeed represent a measure of reduced purchases of offsets. Rather than represent climate ambition though, this result is more likely to demonstrate reduced demand for offsets, likely due to an easier route to emissions reductions from reduced productivity during a recession. It would be useful to reexamine the role of low economic growth on climate ambition at a point in time further out from the global recession of 2008. This leaves us with the following necessary condition, expressed in Boolean terms:

*Strong Public Opinion That Climate Change Is a Serious Problem ← Climate Ambition*
OR
*A country's Climate Ambition is a subset of Strong Public Opinion That Climate Change Is a Serious Problem*

In other words, Strong Public Opinion That Climate Change Is a Serious Problem (CCSER) is a Necessary Condition for Y=Climate Action, and $H_1$ can be accepted as true. It is important to note, though, that all values for CCSER were high, above 6.0 on a 10-point scale (European Commission 2011).

To determine the role other causes play in serving as sufficient, but not necessary, for outcome Y=Climate Ambition, QCA requires that truth tables be created to reveal separate combinations of causal variables leading to the outcome. The Truth Tables for Y=Climate Ambition are below in Table 5. Rows 1-9 include cases in which Y is present.

**Table 5. Truth Table For Proposed Sufficiency Variables of Y=Climate Ambition**

| Row | AGDP | GMPS | ERENEW | CCPRI | Cases | Y=Climate Ambition | Consis-tency |
|---|---|---|---|---|---|---|---|
| 1 | 1 | 1 | 1 | 1 | SE | 1 | .98 |
| 2 | 0 | 0 | 1 | 1 | DK, IE, NL | 1 | .96 |
| 3 | 0 | 1 | 1 | 0 | DE | 1 | .95 |
| 4 | 0 | 1 | 1 | 1 | AT | 1 | .95 |
| 5 | 1 | 1 | 0 | 1 | LU | 1 | .94 |
| 6 | 0 | 0 | 1 | 0 | IT, ES | 1 | .87 |
| 7 | 0 | 0 | 0 | 1 | UK | 1 | .85 |
| 8 | 0 | 0 | 0 | 0 | FR | 1 | .75 |
| 9 | 1 | 0 | 0 | 0 | CY, CZ, LT, MT, SK | 1 | .65 |
| 10 | 0 | 1 | 0 | 0 | | 0 | - |
| 11 | 1 | 1 | 0 | 1 | | 0 | - |
| 12 | 1 | 0 | 0 | 1 | | 0 | - |
| 13 | 1 | 0 | 1 | 0 | | 0 | - |
| 14 | 1 | 0 | 1 | 1 | | 0 | - |
| 15 | 1 | 1 | 0 | 0 | | 0 | - |
| 16 | 1 | 1 | 1 | 0 | | 0 | - |

Note: AT=Austria, CY=Cyprus, CZ=Czech Republic, DK=Denmark, DE=Germany, ES=Spain, FR=France, IE=Ireland, LT=Lithuania, MT=Malta, NL=Netherlands, SE=Sweden

After running standard analysis on these outcomes, the parsimonious solution shows that the existence of strong renewable energy investment and public opinion supporting the importance of climate change are each sufficient conditions on their own:

*ERENEW OR CCPRI =Y*

and that the combination of renewable energy investment and an absence of economic growth can serve as a sufficient condition for climate ambition:

*ERENEW AND ~AGDP=Y.*

If ERENEW is coded "A", CCPRI is coded "B" and ~AGDP is coded "~C", then the sufficient conditions for an outcome of Y=Climate Ambition can be written as follows:

$$A + B + (A * \sim C) = Y$$

ERENEW =Y has a coverage of 66.13% and a consistency of 83.88%. CCPRI =Y has a coverage of 72.98% and a consistency of 78.54%. ERENEW*~AGDP =Y has a coverage of 63.32 % and a consistency of 86.40%.

Returning to my hypotheses from earlier, $H_2$ is affirmed. The combination of the absence of economic growth and a strong presence of renewable energy is sufficient for an outcome of strong climate ambition. $H_3$, which held that Green Party representation in national parliaments would contribute to climate ambition, is disproven. Referring back to Table 4, only two cases of significant climate ambition include Green Party representation as a contributing condition. Several explanations are available for this failed hypothesis. First, MPs may be committed to climate action and not be members of a Green Party in their country because they reject the narrow focus of a Green Party. For example, Denmark does not have any parliamentary representation from a Green Party, and yet it is among the EU's top scorers in climate ambition (12.38%). Second, electoral systems may be to blame for weak Green Party representation in Europe's parliaments. Majoritarian electoral systems may not yield many seats for issues-based minority parties. The existence of countries that have expressed climate ambition but have little or no representation of the Green Party in their national parliament suggests that this measure may not be perfect. Perhaps a measure of proportional representation would better explain the role political systems play in determining climate ambition. In sum, Table 6 represents the aggregated results of the fsQCA analysis.

**Table 6. Results of fsQCA Analysis**

| Condition | Factor | Factor | Consistency | Coverage |
|---|---|---|---|---|
| Necessary | Public Opinion: Seriousness of the Issue | | 97.45% | 57.87% |
| Sufficient "OR" | Renewable Energy Investment | Public Opinion: Climate Change is a Priority | 89.88% / 78.54% | 66.14%/ 72.98% |
| Sufficient "AND" | Renewable Energy Investment | Absence of Economic Growth | 86.40% | 63.32% |

The ETS was designed and executed by the European Commission. It may be the case that scientists and civil servants carry the flag for climate policy so that MPs can focus on other issues. A survey of policymakers, rather than general public, would provide further insight into the division of responsibility and perception of importance among government officials involved in crafting actual policy. Researchers at the London School of Economics (Hix, Scully, & Farrel, 2011) have conducted a survey of Members of European Parliament that shows 70% of these officials supporting more EU-wide regulation on environmental protection standards. A national-level survey of MPs would reveal a more accurate level of climate ambition for each state.

## Conclusions

The Qualitative Comparative Analysis conducted in this study reveals three broad conditions affecting the outcome of a country's climate ambition. First, public opinion on the seriousness of climate change as a problem has a very important role in determining climate ambition in any given ETS country: public opinion on seriousness of climate change is a necessary condition for a country to exhibit climate ambition. This is purely informative in the European model, but an important lesson when looking at alternative markets to export emission trading systems. If North American countries or a group of developing countries (i.e. Brazil, Russia, India, China, and South Africa—or BRICS) hope to implement an effective regional emissions market, it will be necessary for each national government to engage in a public education campaign about the seriousness of climate change.

Second, both an absence of economic growth and a presence of public opinion—indicating that climate change is a priority—contribute to a show of climate ambition in that they are sufficient conditions to climate ambition outcomes. However, since economic growth for the study period (Phase II of the ETS) has been suppressed by a global recession and regional crisis, this information is important mostly to derive what effects are significant independent of economic growth. On a larger scale, there may be important implications for curbing emissions as an economy's growth slows or in individual cases.

The most significant finding of this study for future policies is the identification of renewable energy as an independent sufficient condition for a country's climate ambition. This condition, covering two-thirds of cases included in the study, gives promise to countries and interest groups within countries for promoting the long-term benefits of renewable energy. Not only will renewable energy reduce emissions from fossil fuel use in the immediate term, it appears to contribute to greater ambition in reducing emissions after installation. This condition may explain Denmark's high climate ambition where Green Party representation in parliament falls short. Therefore, countries that make an initial investment in renewable energy have demonstrated the political will to invest in low-carbon technologies and ostensibly a concern about climate change. However, this condition may also imply that countries are unlikely to develop climate ambition until exhausting their fossil fuel supplies. Given the discovery of large amounts of oil and gas recently discovered in Canada and the United States, as well as the fossil fuel reserves in much of the developing world, this may prove a difficult obstacle to overcome.

## Future Research

The best is yet to come in EU ETS studies. As the third phase of the Emissions Trading System commences, several important changes will be introduced to the market that deserve close study. Use of offsets from Kyoto Protocol CDM or JI projects will not be allowed in the next phase. This elimination of the offset spread as a measure of climate ambition should be replaced with a measure of European Union Allocations bought and sold by member countries. The ratio of emissions units purchased in an EU auction to those sold in a country will provide an indicator of climate ambition and progress in the Phase III ETS. Regular reductions in the union-wide cap on emissions will maintain competition for emissions units while reducing GHG emissions from one of the world's most industrialized regions, in aggregate the largest economy globally. The evolution of the European Union's Emissions Trading System will mark an important milestone in the world's fight against climate change.

An essential export of the EU in regards to its ETS will be the application of lessons learned in climate policy and the impact of regulation on developed economies to developing countries. Only by sharing knowledge and building capacity can real progress be made in curbing emissions and preventing the worst of climate change predictions from plaguing future generations. Only if the developed world, currently represented by the only group of countries making good on earlier promises of responsibility, shows that economic restructuring and priority reordering can be successfully accomplished will the entire international community be able to coalesce on a global solution to the steepest test humanity has faced. Facing climate change is at its core a collective action problem. The ETS provides a window into a simulation of how such a problem may be addressed globally—with insight into the reasons and consequences of free-riding and the value of policy leadership.

## Author's Notes

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