Public opinion and environmental policy output: a cross-national analysis of energy policies in Europe

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Public opinion and environmental policy output: a cross-national analysis of energy policies in Europe

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Abstract

This article studies how public opinion is associated with the introduction of renewable energy policies in Europe. While research increasingly seeks to model the link between public opinion and environmental policies, the empirical evidence is largely based on a single case: the US. This limits the generalizability of findings and we argue accordingly for a systematic, quantitative study of how public opinion drives environmental policies in another context. Theoretically, we combine arguments behind the political survival of democratic leaders with electoral success and environmental politics. Ultimately, we suggest that office-seeking leaders introduce policies that seem favorable to the domestic audience; if the public prefers environmental protection, the government introduces such policies in turn. The main contribution of this research is the cross-country empirical analysis, where we combine data on the public's environmental attitudes and renewable energy policy outputs in a European context between 1974 and 2015. We show that as public opinion shifts towards prioritizing the environment, there is a significant and positive effect on the rate of renewable energy policy outputs by governments in Europe. To our knowledge, this is the first systematic, quantitative study of public opinion and environmental policies across a large set of countries, and we demonstrate that the mechanisms behind the introduction of renewable energy policies follow major trends across European states.

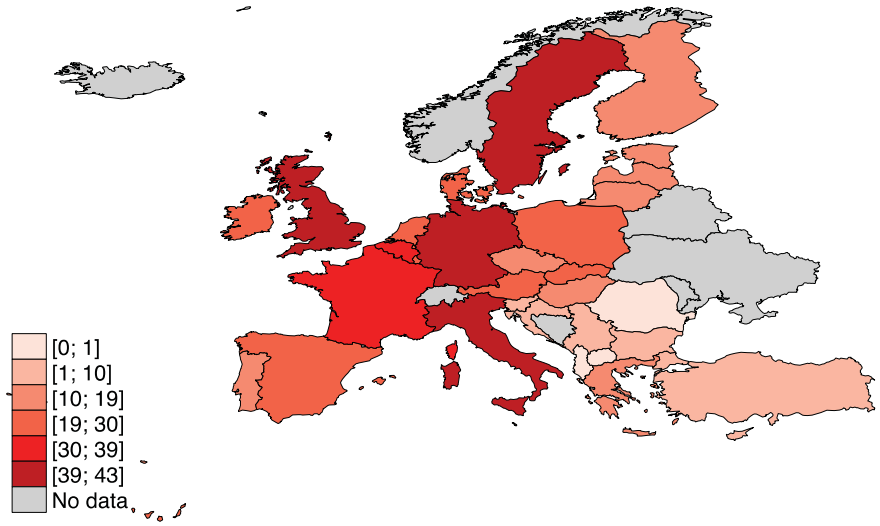
Introduction

Despite a 24 percent decrease in the European Union's (EU) CO_2 energy footprint between 1990 and 2010[4], more than half of EU countries' energy is still derived from fossil fuels. In 2010, EU member states generated 56 percent of energy from oil, coal, and natural gas, but only 19 percent from renewable energy sources. However, the share of renewables is rapidly increasing in Europe in terms of newly added power capacity. In 2010, renewables accounted for only 40 percent of new power added to Europe compared to nearly 90 percent in 2016. Moreover, wind power overtook coal in 2016 to become the second largest power source added in Europe after natural gas. However, national governments largely retain control over energy policy in the EU[5] and, interestingly, there is a considerable amount of variance across EU member states in the rate at which they have added renewable capacity under the EU 2020 Energy Strategy[6]. For instance, Latvia grants tax reductions on diesel and petrol if mixed with biofuels, while no such policy exists in Estonia. Moreover, targets for renewable energy in each country vary to reflect their various starting points and their ability to further increase its use, from a minimum of 10 percent

[4] According to the International Energy Agency, 434 $gCO_2e\,kWh^{-1}$ in 1990 and 331 $gCO_2e\,kWh^{-1}$ in 2010.

[5] In the words of Delbeke and Vis (2015: 69), '[e]ven now under the Lisbon Treaty, it is explicitly stated that the EU's energy policy shall neither affect a Member State's right to determine the conditions for exploiting its energy resources, nor its choices between different energy sources and the general structure of its energy supply.'

[6] This policy, coupled with the EU's Renewable Energy Directive 2009/28/EC, seeks to achieve a 20 percent reduction of carbon emissions, with 20 percent of energy supplied by renewables, and a 20 percent improvement in energy efficiency by the year 2020.



Note: The data used for this graph are based on the IRENA/IEA data, which are introduced in the research design below.

Figure 1. Total number of domestic energy policies, 2015.

in Malta to 72 percent of total energy use in Iceland. Figure 1 underlines this by mapping the total number of energy policies in force in the last year of our sample period (2015) for all states included in our data set. Germany, Sweden, or the UK may be seen as frontrunners for the introduction of renewable energy policies at the domestic level, while Eastern European states, in particular, lag behind.

What explains variation in the use of renewables in Europe around the generally rising trend? Prior work identifies institutional features such as government capacity (Cao and Ward 2015, Schaffer and Bernauer 2014), socio-economic factors, e.g. GDP per capita (Apergis and Payne 2010) and economic growth (Sebri and Ben-Salha 2014), special interests (Ince *et al* 2016, Lyon and Yin 2010) or the diffusion of technologies (Popp *et al* 2011, Neij 1997) as key determinants of countries' renewable energy policies. More recently, scholars have begun to concentrate on public opinion as a crucial explanatory factor, e.g. the electorates' pro-environmental beliefs. The following article focuses on this factor. Despite important insights into how public opinion might create demand for environmental policies, which may then translate into actual policy implementation, previous research has been overly US-centric; it is thus at least questionable whether we can extend existing findings to another context such as the EU. Europe is distinct from the US in terms of (1) a supranational governance structure for most countries (i.e. the EU) and (2) the lack of skepticism regarding climate change and how environmental quality generally is valued. Thus, public opinion might play a different role in the European context than in the US, and the generalizability of findings from the US could well be limited.

We argue accordingly for a systematic, cross-national quantitative study of the relationship between public opinion and environmental policies in another, non-US context. We focus on public opinion in established democracies as a key determinant of energy policies that has so far largely been overlooked in Europe. The main contribution of this research is empirical. We combine public opinion data on environmental attitudes for a large sample of European countries with data on renewable energy policies since the 1970s. The final data allow us to quantitatively analyze the effect of public opinion on the introduction of national energy policies over a large period of time and countries, beyond single cases, thereby presenting robust insights into states' environmental legislation. To the best of our knowledge, this is the first systematic, rigorous cross-national analysis of renewable energy policies and public opinion attitudes that can uncover major trends across states. We also assess the ability of our core explanatory variable to *predict* renewable energy policies (see Ward *et al* 2010) and evaluate the robustness of our main finding by considering alternative hypotheses pertaining to media attention and Internet search-term intensity ('climate change') in the appendix. Our work thus seeks to make a significant contribution to our understanding of how environmental policies emerge at the national level, and we believe that it also has key implications for the effectiveness of these policies as their success also tends to depend on the degree of public support (e.g. Patt and Weber 2014, Bakaki and Bernauer 2016).

Providing a systematic examination of environmental policy outputs as driven by public opinion shifts in a non-US context will significantly improve our understanding of how governments shape their legislation. Empirically, we use a series of survey questions measuring environmental opinion from the Eurobarometer for EU/EC member states in 1974–2015, candidate states from 2001, and states of

interest (Switzerland, Norway and Iceland). The dependent variable, national energy policies in European countries, was compiled using information from the IRENA/IEA global renewable energy policies database. Our results suggest that as public opinion shifts towards prioritizing the environment as an issue, there is a significant and positive effect on the rate of renewable energy policy outputs by governments in Europe. This finding has crucial policy implications and contributes to the academic literature in several ways. First, we investigate the effect of public opinion on energy policy beyond the US. By extending the scope of present work on the relationship between environmental policy outputs and public opinion, we increase generalizability. In addition, we contribute to the larger debate on whether politicians respond to what voters want or if parties and governments merely push for their own agenda (see Huber and Powell 1994, Stimson *et al* 1995, Powell 2000). Our work presents strong and robust evidence for the former and that governments react to the preferences of the median voter, which mirrors, e.g. Ezrow (2010) who focuses on Western Europe and finds parties to be vote-maximizing and center-oriented. Parties tailor their ideologies to appeal to a broader spectrum of the electorate, and we provide further evidence for this in the context of renewable energy policies.

Argument

We build upon and contribute to an extensive literature investigating the effect of democracy on environmental policies. The first strand in this literature investigates which institutional features account for differences in policy outputs. Such institutional features range from inclusiveness (Böhmelt *et al* 2016) and government resources (Cao and Ward 2015) to the strength of left parties (Neumayer 2003). According to this work, democracies are more likely to commit to environmental policies than non-democracies (Bättig and Bernauer 2009, Neumayer 2002, Fiorino 2011, Schaffer and Bernauer 2014). However, controlling for other factors, democracies do not emit significantly less carbon per-capita (Cao and Ward 2015, Ward 2008). On theoretical grounds, democracies are only expected to reduce carbon emissions if there is public support for this, so the effect of democracy will be mediated by demand for action. This leads to the second strand, which explores the demand side, i.e. the effect of public opinion on environmental policy. In general, as public sentiment shifts toward pro-environmentalism, policymakers sense such a shift and may then legislate pro-environmental policies to better reflect public demand. However, this literature is mainly focused on the US (see Agnone 2007, Anderson 2011, Weaver 2008). In addition, those studies analyzing a broader sample cross-nationally tend to conflate environmental performance with policy (see Weaver 2008, Shum 2009), although performance may lag behind developments in public policies that take time to have an effect[7].

Prior work finds that the public's climate beliefs impact the voting behavior of policymakers and the passage of pro-environmental policies (Agnone 2007, Anderson 2011, Shum 2009, Weaver 2008). In the US, senators and representatives vote more pro-environmentally, the more concerned their constituents are about climate change (Agnone 2007, Anderson 2011, Johnson *et al* 2010, Vandeweerdt *et al* 2016). Globally, countries with pro-environmental attitudes tend to have a greater number of environmental-friendly policies, particularly if the public is willing to make economic sacrifices for the environment (i.e. pay higher prices) (Weaver 2008). Likewise, other scholars identified a lack of public support as a major barrier to transitioning to a low-carbon economy (Geels 2013, Wiseman *et al* 2013). But what are the underlying mechanisms behind these relationships? We outline a general and comprehensive mechanism that links public opinion to environmental policy outputs in democratic states in three steps. First, all countries in our sample are democratic, and their leaders can be assumed to have the primary incentive of retaining power. In pursuit of this goal, second, leaders seek to introduce policies that favor the domestic audience. And, third, if the public wants to protect the environment, the government introduces such policies so as to maximize its chances of staying in power. We believe that environmental politics is not an exception to this.

In detail, first, democratic institutions incentivize leaders to provide public goods and to respond to constituents' needs (e.g. Bueno de Mesquita *et al* 2005). The underlying mechanism for this is that democratic leaders can be removed more easily from office due to, e.g. regular elections, and politicians thus have the incentive to meet their voters' needs (Dahl 1971). In addition, democracies have larger winning coalitions (i.e. those who control enough power to keep a leader in office), and the relative cost of providing private goods to these individuals as a means of maintaining power is therefore higher than in autocracies. Instead, democratic leaders provide public goods to retain power. But how do democratic politicians provide public goods in line with voters' preferences?

Democracies provide the opportunity for citizens to influence politics. Citizens can do so via multiple channels including interest groups, the media, demonstrations, and, as indicated above, voting in elections (Cao and Ward 2015, Congleton 1992). Subsequently,

[7] More specifically, Weaver (2008), analyzing cross-sectional data for 64 states, finds that people's willingness to pay more for environmental quality is positively associated with measures from the 2005 Environmental Sustainability Index. And Shum (2009) focuses on the 2008 Environmental Performance Index and finds some evidence that public opinion can explain the divergences and outcomes observed in environmental quality.

politicians will supply public goods in line with the median voter's attitude (Downs 1957). Since politicians are concerned about votes and can choose their positions accordingly to maximize their chances to win the next election, they will adopt policy platforms that are closer to the ideal policies of the median voter. This, in turn, should lead to a greater provision of public goods desired by the median voter. And, in fact, environmental quality, or implementing less emission-intensive energy policies and mitigating climate change as in our context, is a public good. This mechanism mirrors, in principle, Shum (2009: 282) who tests '[whether], where voters and citizens express a favorable opinion of increased environmental regulation, governments will enact more stringent policies for ensuring environmental quality' (see also Congleton 1992).

However, the literature suggests that policy output is unlikely to be continuously responsive to the *level* of public support for action. Rather, policy output tends to shift in a discontinuous manner (Baumgartner and Jones 1993, Jones 1994, Jones and Baumgartner 2005, True *et al* 2007), responding to *shifts in* the level of support (Wlezien 1995). Most of the time in an issue area, policy change is incremental, as attention is not focused on that area at the macro level, and a coalition of interests has accreted at policy sub-system level (Mazey and Richardson 2006). However, issues occasionally break out into the macro-political realm where elected politicians operate and where major policy shifts occur. Because of bounded rationality, politicians can only process issues sequentially (Walgrave and Dejaeghere 2016), and to break through their attention thresholds requires a positive feedback process whereby pressure for change builds. Policy entrepreneurs, the media, and public opinion positively feed-back off each other until punctuation in policy occurs. Broad public support for policy change, signaled by a major shift in public opinion, is not necessary for an agenda breakthrough, but it adds weight to other forces at work pushing against policy inertia (Jones and Baumgartner 2012). Thus, shifts in public opinion should *increase the chances* of non-incremental change, although the links between it and public policy change are complex and discontinuous. Punctuated equilibrium theory has now been widely applied (see True *et al* 2007), and has found application to US environmental policy (Baumgartner 2006). Given the complexity of policy-making and the range of competing theories, it is not surprising that it has been subject to quite extensive criticism, because to some extent it ignores the impact of broader social, economic, and political processes (e.g. John 2012, 163–165; Flink 2015). Nevertheless, we argue that it is useful for thinking about the passage of renewable energy policies in Europe and test the following empirical implication: *the larger the shift in public support for environmental action, the more likely it is that new policies will emerge and the greater the number of new policy instruments can be expected to be introduced.*

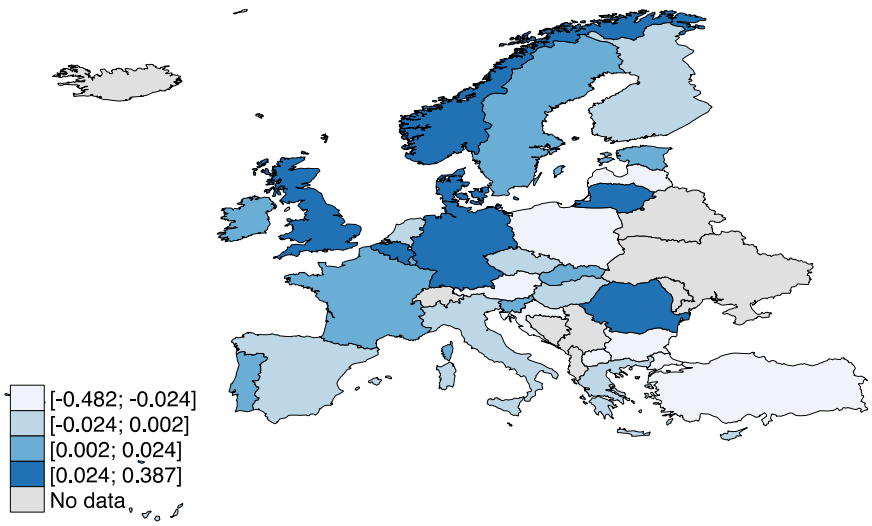
Research design

To examine the effect of shifts in public opinion on governments' responsiveness and, hence, policy output in a cross-national context, we compiled data on the core variables of interest for a sample of established European democracies since the 1970s. The country-year is the unit of analysis in this time-series cross-sectional data set, and the appendix gives a detailed overview of states and years included in this sample. The cases in our analysis are predetermined by data availability for our dependent variable, which we compiled using information from the IRENA/IEA global renewable energy policies database, and our core explanatory variable from the Eurobarometer.[8]

Our outcome variable focuses on policy outputs that could improve environmental quality. One of the most significant environmental problems of our time is climate change, and climate change is strongly related to countries' energy policies (e.g. Pfeiffer and Mulder 2013, Schaffer and Bernauer 2014). Moreover, a key step to limiting the effects of climate change and transitioning to a low-carbon society is the de-carbonization of the energy sector (OECD/IEA/NEA/ITF 2015). Accordingly, we employ a measure of states' renewable energy policies. We compiled data from the joint IRENA/IEA global renewable energy policies and measures database[9]. We concentrate specifically on national policies belonging to the following categories: economic instruments, information and education, policy support, regulatory instruments, research and development, and voluntary approaches. The date each policy came into force and ended is provided by the IRENA/IEA database, and we used this information to code a variable counting the number of renewable energy policies a state has introduced in each year over our sample period (see also Johnstone *et al* 2010: 141ff). As Cao and Ward (2017: 89f) emphasize, this measure 'is more closely related to climate change [than general measures of the stringency of environmental policy], although it does not directly capture carbon taxes (Ward and Cao 2012) and energy conservation

[8] An alternative hypothesis might state that policy change is driven by attention. This could be measured through media coverage (Newig 2004, Schmidt *et al* 2013) or internet search-term intensity (Qin and Peng 2016). As an anonymous reviewer suggested, attention changes far more quickly than opinion and, therefore, could be a strong potential predictor of policy change (Newig 2004). The appendix presents some relevant analysis. Specifically, we have compiled search-term intensity data from Google Trends using the term 'climate change' (see also Qin and Peng 2016) and extrapolated the media data from Schmidt *et al* (2013). In turn, we re-estimated our main model while including the two new items in addition. As shown in the appendix, the Google Trends variable is positively signed and statistically significant, while the media item is positively signed as well, but fails to achieve a conventional level of significance. Most importantly, though, our main variable remains robust to this change in the model specification.

[9] Available online at: www.iea.org/policiesandmeasures/renewableenergy/.



Note: The data used for this graph are based on the Eurobarometer. Opinion data in this figure are averaged across all years in our sample.

Figure 2. Countries' average change in environmental public policy mood, 1974–2015.

policy.' We have observations for 735 country-years, with a mean value of 0.867 new policies introduced per year (standard deviation of 0.132).

For simplicity and ease of interpretation, we employ OLS regression models in our main estimations, but we also present count models (negative binomial and Poisson regression models) that take the underlying (count) data-generating process of our outcome variable more directly into account. We include country fixed effects alongside the substantive predictors to capture any time-invariant unit-level forms of cross-section heterogeneity; and we include a temporally lagged dependent variable, which controls for a state's introduction of national policies in the previous year. Thus, we allow for the potential influence of countries' past behavior on their current policy implementation[10]. We also address temporal autocorrelation more generally with cubic polynomials on the time elapsed (in years) since the last introduction of at least one domestic renewable-energy instrument (Carter and Signorino 2010).

The core explanatory variable of our analysis is based on the Eurobarometer survey[11]. The EU Commission has conducted such surveys in EC/EU member states since 1974, candidate states as of 2001, and several other countries of interest (e.g. Switzerland, Norway, Iceland) in various years. Unfortunately, the Eurobarometer does not ask the same question(s) in every survey, and even if the intention behind a question is the same, formulations may be different. With a view to capturing our theoretical concept as closely as possible while maximizing country-year coverage, we ultimately opted for a combination of two Eurobarometer survey items. First, there is the question, which asks whether respondents think that fighting pollution is (4) not at all important, (3) of little importance, (2) important, and (1) very important. The item has not been included in all Eurobarometer surveys, however. In fact, second, it seems that this question has been replaced by another ordinally scaled question in some, and particularly in more recent, surveys: 'please tell me, for the problem of protecting nature and fighting pollution, whether you personally consider it a very important problem (1), important (2), of little importance (3), or not at all important (4).' We combined these two survey questions as follows: we first dropped the 'don't know' answers and missing values. Afterwards, we merged both variables as they follow the same scale, and inverted this so that higher values pertain to a more favorable attitude towards fighting pollution and protecting the environment. Third, we aggregated this individual-level information to the country level by averaging across respondents. We thus end up with a variable measuring the public mood towards protecting nature and fighting pollution, which theoretically ranges in [1; 4] and with higher values indicating that a larger share of respondents perceives environmental protection as more important. Finally, we created a first-difference measure by subtracting the variable's values in *t-1* from current values. Our final item thus captures *shifts* in public opinion, with a mean value of −0.001 (standard deviation of 0.468). Figure 2 maps public opinion on environmental protection for all states included in our analysis averaged across the years for which data are available. In combination with figure 1, note that this graph lends some initial support to our theoretical expectations as most countries associated with a shift towards more environmental-friendly

[10] Given the structure of the data, serially correlated errors within countries might be possible; the temporally lagged dependent variable addresses this (Beck 2001).

[11] Available online at: http://ec.europa.eu/public_opinion/index_en.htm.

Table 1. Public opinion and the energy policy outputs.

	(1) OLS	(2) OLS	(3) OLS	(4) Negative binomial
Energy policies$_{t-1}$	0.213**	0.119**	0.137	0.064
	(0.079)	(0.055)	(0.084)	(0.044)
Public opinion change	0.303**		0.353**	0.284**
	(0.134)		(0.131)	(0.117)
Civil society participation$_{t-1}$		−2.856	−4.920*	−3.501
		(2.398)	(2.891)	(2.672)
Democracy$_{t-1}$		0.236	0.515**	0.657***
		(0.191)	(0.220)	(0.245)
Economic globalization$_{t-1}$		0.040***	0.016	0.019
		(0.010)	(0.015)	(0.022)
Energy use$_{t-1}$ (ln)		0.129	0.209	1.968*
		(0.614)	(0.589)	(1.083)
Population$_{t-1}$ (ln)		1.599	0.040	−0.148
		(2.639)	(3.543)	(0.560)
GDP per capita$_{t-1}$ (ln)		0.247	0.675**	1.110***
		(0.192)	(0.252)	(0.271)
Constant	1.202***	−31.352	−9.558	−26.958***
	(0.146)	(41.108)	(54.825)	(9.870)
Obs.	367	546	338	327
Country fixed effects	Yes	Yes	Yes	Yes
Temporal controls	Yes	Yes	Yes	Yes
R^2	0.279	0.077	0.242	0.070
AIC	1149.714	1704.465	1036.531	662.656

Note: Obs. = number of observations; R^2 = (pseudo) coefficient of determination; AIC = Akaike information criterion; standard errors clustered on country in parentheses.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

policy moods (positive trend) are, in fact, associated with a larger number of energy policies active in 2015[12].

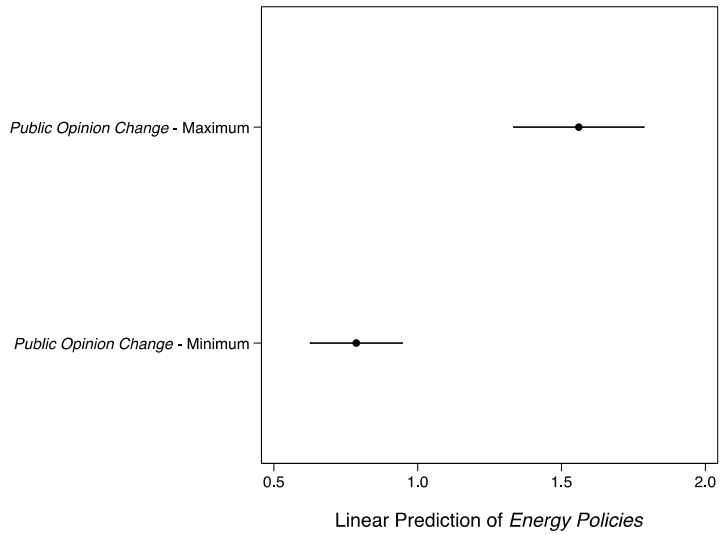
We also include a series of control variables, which may affect our dependent variable to avoid omitted variable bias. We primarily followed earlier (quantitative) studies that have a similar focus to our work (e.g. Pfeiffer and Mulder 2013, Schaffer and Bernauer 2014, Cao and Ward 2017), and eventually identified six controls that seem exogenous to our dependent variable, that control for alternative mechanisms influencing the introduction of energy policy, and that may well be correlated with the core predictor. These controls are described in the appendix.

Findings

Table 1 summarizes the four main models that we estimate. The first only includes the core variable of interest alongside the lagged dependent variable, country fixed effects, and the temporal controls. Model 2 only comprises the control variables and the country fixed effects as well as the lagged dependent variable and temporal controls. Model 3 constitutes our full model that incorporates all explanatory variables as well as country fixed effects, the lagged dependent variable, and the temporal controls. Model 4 is identical to Model 3, but it relies on a fixed-effects negative binomial regression model specification that takes the underlying (count) data-generating process more directly into account than ordinary least squares.

The table entries pertaining to OLS regression coefficients (Models 1−3) can be interpreted directly as marginal effects. With regard to our hypothesis, *Public Opinion Change* is positively signed and statistically significant at conventional levels in all OLS estimations and in the negative binomial regression (Model 4). Adding or dropping variables does not change this finding, and a series of additional specifications in the appendix further demonstrates how robust this result is. In substantive terms, when increasing *Public Opinion Change* by one unit, i.e. when the public has become more favorable of environmental protection over the last year, the predicted number of energy policies introduced in the current year increases by 0.303–0.353 (Models 1 and 3, respectively). Similarly, both in terms of significance and substance, the negative binomial specification suggests a predicted increase of 1.33 policies when *Public Opinion Change* is raised by 1. Figure 3 plots the change in the predicted number of policies when changing *Public Opinion Change* from its minimum to its maximum (based on Model 3): the linear prediction of *Energy Policies* is 1.56 at the maximum of our core explanatory variable, while it decreases to 0.79 when *Public Opinion Change* is at its minimum. The difference between both point estimates is statistically significant as the confidence intervals do not

[12] Our main explanatory variable thus focuses on pollution and environmental issues more generally. This is driven by the fact that the Eurobarometer time series do not consistently cover climate change as such; environmental quality and pollution have a much broader coverage over the years. For the outcome variable, in turn, we do need a cross-country comparable indicator of policy outputs that are favorable to the environment—and renewable energy policies meet this criterion. The assumption we make in this regard is that more favorable attitudes towards the environment and environmental quality should not only be positively related to any policy that (potentially) improves the environment, but also renewable energies that more specifically address climate change.



Note: Graph displays point estimates and 95 percent confidence intervals (horizontal bars) for first differences. A first difference is the change in the linear prediction of the outcome variable associated with a change from the minimum to the maximum value of *Public Opinion Change* while holding all other covariates constant at their means.

Figure 3. *Public Opinion Change*—First Difference.

overlap. In the appendix, we plot the simulated coefficient estimate of *Public Opinion Change* using the approach suggested in King *et al* (2000). As the coefficient is a simulated parameter, we present a density plot that captures its distribution. The graph demonstrates that the simulation does not call into question our conclusion about the statistical significance of the variable, emphasizing that the public opinion on environmental protection in a country directly affects governmental policies in turn. In other words, there is strong and robust support for our hypothesis.

For illustrating that our core variable of interest not only has explanatory power according to statistical significance, but also predictive power, we provide three goodness-of-fit measures for prediction accuracy in an in-sample setup, i.e. how accurate are the 'conditional statements about a phenomenon for which the researcher actually has data, i.e. the outcome variable has been observed' (Bechtel and Leuffen 2010: 311; see also Ward *et al* 2010)? First, Theil (1966) U is the square root of the ratio between the sum of squared prediction errors of the baseline model (i.e. Model 3) and the sum of squared prediction errors of a naïve model, i.e. a 'no-change prediction' where the number of policies introduced in in *t*-1 fully corresponds to number of policies in *t*. If Theil's U is larger than 1, the model performs worse than the naïve model; values of Theil's U smaller than 1 indicate that the 'theoretically informed model' performs better than the naïve specification. Second, the mean squared prediction error (MSPE) pertains to the expected value of the squared difference between the observed values of the outcome variable and the predicted ones. Third, the mean absolute percentage error (MAPE) is defined by the average of the unsigned percentage error, i.e. it is the expected value of the absolute difference between the observed values of the outcome variable and the predicted values divided by the actually observed values. The closer the value of any of the last two statistics is to 0, the more accurate is the model in making predictions. However, the MSPE is scale-dependent, while the MAPE is not. In terms of the latter, less than 10 percent of error constitute a highly accurate prediction, 10–20 percent stand for a good one, and 20–50 percent may still be a reasonable prediction. More than 50 percent of error according to the MAPE are inaccurate.

Table 2. Predictive power.

	Theil's U	MSPE	MAPE
Model 3 (Full Model)	0.852	1.178	0.445
Model 3 w out^{-1} Public opinion change	1.308	1.280	0.463

We calculated all three measures for two scenarios (table 2): the first one is identical to Model 3 above, the second is like Model 3 but omits *Public Opinion Change*. In the first scenario, Theil's U is 0.852, the MSPE is 1.178, and we obtain a MAPE of 0.445; in the second scenario, Theil's U stands at 1.308, the MSPE is 1.280, and the MAPE has a value of 0.463. Thus, first, the predictive power of our core variable of interest is established as the prediction error increases according to all three measures when omitting *Public Opinion Change*. Second, in general, the predictive power of our model is reasonably strong as the prediction error is at around 44 percent, but it increases by around 2 percentage points when omitting *Public Opinion Change*.

In terms of the control variables, the poor performance of most of them can be explained by the inclusion of fixed effects, while estimating a sample over a relatively short time period. Fixed effects models lack the ability to make inferences about time-invariant or slow-moving variables, because those covariates are highly collinear with fixed effects and their coefficients are either not identified or difficult to estimate with precision (Plümper and Troeger 2007). The only robust control variable is $Democracy_{t-1}$ that exerts a significant and positive impact on the number of energy policies introduced in each year in most of the models. As expected, a more democratic system is strongly associated with more environmental-policy output. In Model 3, for example, when raising $Democracy_{t-1}$ by one unit, the predicted number of policies increases by about 0.53 in the next year.

Finally, it seems worth discussing the negative effect of $Civil\ Society\ Participation_{t-1}$ in Model 3. The rationale behind including this variable as a control, as further discussed in the appendix, is that more inclusive systems, i.e. societies with a more robust civil society, should produce more policies in response to environmental threats and should have better environmental outcomes (Böhmelt *et al* 2016, see also von Stein 2017). This, however, neglects the larger debate on the effects of civil-society participation on environmental policy (e.g. Koontz and Thomas 2006, Young *et al* 2013, Newig *et al* 2017), which shows that a negative effect of civil society groups on environmental policymaking may not be entirely unexpected. On one hand, greater inclusiveness not only leads to enhanced participation of green civil society, but also of other interest groups such as coal and oil lobbies. The variable we employ comprises groups that may or may not have environmental-friendly ambitions. On the other hand, indeed, Bernauer *et al* (2013) contend that the effect of environmental civil-society groups on international environmental policy outputs may differ across democracies and non-democracies: paradoxically, the marginal influence (effect) of green civil society could be negative in democracies as these kinds of regime usually implement more environmental-friendly policies anyway. And our sample of European states exclusively comprises democratic countries.

Conclusion

This article is one of the first to present a systematic, cross-national study of the relationship between public opinion and environmental policies as measured by the implementation of renewable energies in a non-US context. We found that shifts in public opinion in the direction of pro-environmentalism significantly and substantively increase the adoption of renewable energy policies in Europe between 1974 and 2015. Thus, public opinion is not only relevant to the passage of renewable energy policies in the US, but also in Europe. This is not to say that shifts in public opinion are the only relevant factor for renewable energy policy, but that it can be a key catalyst. The main contribution of our work lies in the empirical analysis that sought to regress renewable energy policy data on environmental attitudes, while assessing the predictive power of our core explanatory item and comprehensively assessing the robustness of the main result with a series of additional analyses as summarized in the appendix. Ultimately, this article sheds new light on the processes behind the emergence of domestic-level environmental policies and it may have critical consequences the success of those policies, since public support is usually a key driver here as well (see Patt and Weber 2014, Bakaki and Bernauer 2016).

Future research should investigate what causes these shifts in public opinion. Many studies analyze the factors affecting environmental beliefs using individual-level predictors. The most consistent predictor is political orientation (Drews and Van den Bergh 2016), but other studies observe significant correlations between climate change beliefs and knowledge, education, gender, as well as age (Nisbet and Myers 2007, Rosa and Dunlap 1994, Bakaki and Bernauer 2016). However, it is still unclear what causes these shifts in public opinion, which we observed in the Eurobarometer surveys. If environmental groups understood this dynamic, public opinion could be (purposefully) shifted as a means to catalyze the passage of renewable energy policy at the federal level.

Moreover, we treated different types of renewable energy policies similarly, and simply counted the number of policies in aggregate. An interesting next step could be to differentiate policies and see whether shifts in public opinion lead to a particular set of policies being implemented, and what the implications of adopting a restricted set of policies are in terms of effectiveness (i.e. environmental performance). Finally, given the increasing importance of mitigating and adapting to climate change, our work clearly shows that public opinion sets the constraints in which policy can develop. Therefore, citizen support is a necessary prerequisite for the passage of renewable energy policies.

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