The Comparative Politics of Climate Change Mitigation Measures: Who Promotes Carbon Sinks and Why?

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Abstract

This article presents an analysis of twenty-six industrialized countries' support for the carbon-sequestration-based mitigation measures carbon capture and storage (CCS) and reduced emissions from deforestation and forest degradation (REDD+) during the 2007–2014 period. The article explores whether these proposed solutions to climate change share characteristics that make them feasible for reasons that can be observed in cross-national patterns. Insights from political economy, public policy, and international relations form a "triply engaged" theoretical framework. Relationships are tested using bivariate statistics and multivariate regressions. The analysis reveals that the same states show stronger support for both CCS and REDD+, and mostly for the same reasons. Proponents of such measures are generally petroleum-producing, large, and affluent, and they do not take on more ambitious mitigation targets. This article is the first to suggest that the widely different carbon-sink-based mitigation measures CCS and REDD+ may share similar political functions in similar political contexts.

An important puzzle in the study of global environmental politics is what factors influence states' behavior in the climate policy domain (Bernauer 2013). In this journal, Purdon (2015, 17) encouraged researchers to combine knowledge on public policy, political economy, and international relations in "a triply engaged climate politics research program" to find out. His recommendation is echoed by Duit et al. (2016) and others, who advocate "bringing the state back in" and letting established political science insights inform climate-policy-specific analyses (Rykkja et al. 2014). Recent contributions to this literature have compared instrument choices, with an emphasis on the generic public policy toolkit in use, such as legislation or economic sanctions (Dubash et al. 2013; Lachapelle and Paterson 2013; Urpelainen 2013). Few, however, have

* I thank Espen Moe, Gunnar Fermann, Zan Strabac, Ole Magnus Theisen, Erlend Sandø Kiel, Per Marius Frost-Nielsen, Lillian Hansen, and two anonymous reviewers for their comments on this article. I am also grateful that Erick Lachapelle, Matthew Paterson, Thomas Bernauer, and Tobias Böhmelt generously shared insights from their own quantitative climate policy analyses in the preparatory stages of this research.

Global Environmental Politics 18:1, February 2018, doi:10.1162/GLEP_a_00444

studied why states prioritize the menu of mitigation measures—the concrete technologies, processes, or practices to reduce emissions—so differently (Edenhofer et al. 2014, 1266). Clearly, hydropower cannot replace coal in states without hydropower potential. However, could certain mitigation measures serve political functions that make them feasible for reasons that can be observed in cross-national patterns? This would imply that different types of climate solutions may be classified on the basis of their political implications, which would make an important contribution to better understanding the factors that condition politically viable mitigation action and state behavior.

Addressing one potentially important class of mitigation measures, this study asks why some industrialized states favor *carbon-sink-based* options. Sinks are processes, activities, or mechanisms that remove greenhouse gases from the atmosphere. Such carbon sequestration is likely vital for keeping the agreed-upon 2°C target within reach (Edenhofer et al. 2014).[1] Carbon lock-in theory, moreover, suggests that sink-based measures may be more feasible for states dependent on fossil fuels, because such options mobilize less political resistance than do those that confront the current political economy (Unruh 2002, 320). Thus, if carbon-sink-based measures promise substantial and necessary carbon cuts without disrupting infrastructure or power relations, they should appeal to policy-makers of many types.

To examine this idea, this study's fundamental proposition is that two sink-based but otherwise dissimilar "buzzword" concepts in global climate politics, carbon capture and storage (CCS) and reduced emissions from deforestation and forest degradation in developing countries (REDD+), share fundamental political implications that define their feasibility for industrialized countries. CCS refers to technological value chains in which carbon is captured at a source, traditionally from fossil fuel combustion, and permanently stored in geological reservoirs (Gibbins and Chalmers 2008). REDD+ is the cooperation mechanism under the international climate regime to protect tropical forests in developing countries, which intends for industrialized states to offer economic incentives for protecting forests as giant biological sinks (Gupta et al. 2013). The two are further introduced below. "Carbon sink governance" (Dilling 2007) has previously been addressed in this journal, in terms of both biological (Di Gregorio et al. 2015) and mechanically infused (Tjernshaugen 2012) sequestration. However, these two approaches have not previously been studied in combination. To empirically test this unconventional assumption, I developed a dataset covering CCS and REDD+ policies for twenty-six industrialized countries in the period 2007–2014. Offering novel data and "triply engaged" theory, this study states'

1. In parts of the literature, "sinks" refer to processes based on photosynthesis only. This article, however, considers sinks in a wider sense, including geological reservoirs, following a definition of carbon sequestration as the "capture and secure storage of carbon that would otherwise be emitted to or remain in the atmosphere" (Herzog and Golomb 2004, 277). Although not fully consistent with UNFCCC language, I stick to the "sink" term both to focus on carbon accumulation in reservoirs and for simplicity.

preferences for these mitigation measures with insights from theories of political economy and politics at the national *and* international levels using bivariate and multivariate statistics.

If CCS and REDD+ share fundamental political implications as sink-based measures, we should expect both strong empirical covariation in support of the two among the same countries *and* similar covariation in the political and economic indicators prescribed by theory. First, building on carbon lock-in theory, the energy political-economy perspective addresses energy consumption and production concerns. Second, insights from the domestic-level comparative environmental politics literature propose that national decision-making systems and normative commitments influence sink policies. Third, international relations reasoning suggests that power, interests, and norms explain state behavior in the international climate regime setting. The empirical analysis shows a remarkably consistent relationship among states with ambitious CCS and REDD+ policies: those that pursue CCS also pursue REDD+ at a similar level. Although these states vary considerably with respect to their political institutions, normative ambition, and energy use, sink proponents are generally petroleum-producing, affluent, and large states without the most ambitious mitigation targets. These compelling patterns suggest that the two sink-based concepts could indeed share fundamental political functions that make them feasible in similar political contexts.

These results show how fossil energy production defines national climate political realities. This link was expected for CCS, but a similar claim has not previously been supported for REDD+. Thus, if sink-based options represent one class of mitigation measures, the analysis indicates that preferences for mitigation measures are political products of strategic significance. Because advanced sink policy is not a product of elevated climate political ambitions, but rather of the preferences of the largest and most powerful states, promoting sink-based mitigation could represent a way of signaling commitment to the climate regime's normative purpose while hedging national petroleum interests. This suggests the interpretation that sink-based measures are preferable strategies for states looking to uphold the current energy economy while also being sensitive to demands for climate action. The fact that little Norway accounts for a disproportionate share of both global CCS and REDD+ budgets exposes the underdeveloped or symbolic nature of the effort during the 2007–2014 period. As a contribution to the comparative study of global environmental politics, this article shows that addressing the politics of climate change mitigation measures using novel empirical data and "triply engaged" theory may produce rewarding results.

Theory

CCS and REDD+ as Comparable Carbon-Sink-Based Mitigation Measures

This study seeks to map and explain political support for CCS and REDD+ as sink-based mitigation measures. The two serve this purpose as measures firmly established in global climate politics that approach carbon sinks from different angles. These characteristics allow for cross-national comparisons and a broad look at the political implications of such measures. Indicative of their political relevancy, CCS is the only such measure to repeatedly be the subject of joint G8 policy (International Energy Agency [IEA] 2010). Likewise, REDD+ is the only mitigation measure with a dedicated negotiations track within the international regime. Not least, most Intergovernmental Panel on Climate Change (IPCC) scenarios that are consistent with the 2°C target assume that widespread use of sink-based measures and sinks will be vital for achieving "negative emissions" (Edenhofer et al. 2014). The starting point for this analysis is thus to establish whether support for CCS and REDD+ correlates across states. I will briefly describe the evolution of CCS and REDD+ as concepts in global climate politics before considering potential causal explanations for this assumed relationship.

The IPCC launched its milestone special report on CCS in 2005, advancing global awareness of the concept (IPCC 2005). By that time, most industrialized countries had shown interest in CCS, and some had even stored carbon in geological formations since the 1990s (Meadowcroft and Langhelle 2009; Tjernshaugen 2008). Within the climate regime, eager proponents pushed for a formal recognition of CCS as a mitigation measure, including as an eligible activity under the Kyoto Protocol's Clean Development Mechanism (CDM). Not all were convinced at first, but CCS was eventually allowed within the CDM in 2011 (Bakker et al. 2010). Despite this recognition, a massive global CCS deployment did not materialize. For example, the EU-wide incentives, based on revenue from the Emissions Trading Scheme, failed to generate sufficient funds, and some national governments were reluctant (Claes and Frisvold 2009). In developing countries, CCS did not materialize despite the potential for funding from CDM and official development assistance (ODA) contributions. As of 2016, only 7 million tons of CO_2 equivalents per year was captured, stored, and adequately monitored globally (IEA 2016). However, because some increasingly see CCS as an alternative to reducing emissions from industry, and because there are few alternatives for staying within 2°C without it, global CCS implementation will see an upsurge, its proponents argue (Global Carbon Capture and Storage Institute [GCCSI] 2016).

Tropical forests also entered global climate politics in 2005, when a group of forested developing countries suggested adding a separate mechanism to incentivize reduced emissions from deforestation (RED) to the international regime. The scope was later extended to forest degradation (REDD) and to "conservation, sustainable management of forests, and enhancement of forest carbon stocks" (REDD+). By 2013, negotiations over REDD+ were finalized. The mechanism aimed for verifiable emissions reductions (VERs), with industrialized states and nonstate actors paying forested countries for their proven results. Although some industrialized countries might like to see REDD+ as part of a future market-based cooperative mechanism, VERs cannot be used to offset domestic emissions (Gupta et al. 2013). Norway's flagship arrangements with

Brazil and Indonesia are examples of countries' experiments with bilateral REDD+ agreements, but we have yet to see implementation at the scale needed to halt and reverse deforestation in the Global South (Norman and Nakhooda 2014). Can theory explain industrialized states' potentially mixed commitment to these options?

Explanatory Focus I: Energy Political Economy

In a carbon lock-in setting, government and industry join forces to resist changes to the current fossil-fuel-based economy (Unruh 2000). This leads to path dependency in both physical and social systems (Pierson 2004). The expectation is that fossil-fuel-dependent states are carbon-locked-in because of the overwhelming importance of fossil energy to the economy. In this situation, politically acceptable climate solutions may tackle the environmental consequences of a harmful process but not transform the system (Unruh 2002).[2] Carbon-sink-based measures fit that category because they focus on carbon sequestration. The structural nature of fossil fuel consumption could lead us to expect any fossil-fuel-dependent state to promote carbon-sink-based policies. However, different *types* of fossil fuel dependency may have different effects. From an energy security perspective, "security of supply" and "security of demand" indicate that net importers and producers will have different concerns (Fermann 2014). Consumers may discriminate less with regard to energy sources as long as their needs are met. Producers, however, may strive to sustain a profitable sector of the economy. From a carbon lock-in perspective, such considerations affect the climate policy options available by triggering energy producers to be more protective of their petroleum sector. Harrison (2015) suggests that in the "carbon value chain," upstream countries that export fossil energy may be able to tax territorial carbon emissions, but downstream countries are less likely to impose such sanctions, given the vital importance of their imported, scarce energy supplies. If consumers and producers are not carbon locked-in in the same way, they may not be equally interested in sink-based mitigation. Indeed, early empirical findings suggested that petroleum exporting countries could be stronger proponents of CCS (Tjernshaugen 2008). The analysis here controls for fossil energy *consumption* and *production*, and strong covariation of CCS and REDD+ in similarly carbon locked-in polities.

Explanatory Focus II: Public Policy

For assessing other public policy factors, the basic assumption remains that CCS and REDD+ are similar products of similar national politics. If so, we would

2. However, the political impact of REDD+ in the forested developing countries may be transformative indeed!

expect similar support for sink-based mitigation measures in domestic contexts with similar climate commitments and decision-making systems (Duit 2014; Harrison and Sundstrom 2010). This is largely unexplored territory in the empirical literature, but studies of Norway have shown that this country's CCS and REDD+ strategies in part were due to a consensus-oriented parliamentary system trying to bridge the needs of an influential petroleum sector with an ambitious emissions target (Hermansen 2015; Roettereng 2016). However, competing claims can be made as to whether a stronger or a weaker commitment to reducing emissions leads to more ambitious sink policies. Proponents argue that widespread application is imperative, given the overwhelming need for cutting emissions. Critics warn that focusing on sinks sidetracks us from what is ultimately needed, which is replacing fossil energy systems.

The comparative environmental politics literature advises that different national decision-making systems may produce different policies. This could apply to support for different climate solutions. Some propose that parliamentary systems are more prone to adopt environmental policies than are presidential ones (Duit et al. 2016). Others suggest that federal systems are more likely to address environmental concerns than are centralized states, because federal systems provide more decision-making instances (Lachapelle and Paterson 2013). However, as some actors have resisted CCS in Germany, the federal system's many veto points have been used to explain a resulting reluctance toward CCS in that country (Inderberg and Wettestad 2015). Moreover, capitalist democracies may be grouped as either liberal (LME) or coordinated (CME) market economies, with the latter group being characterized by elaborate institutionalization of societal interests (Hall and Soskice 2001). This may be relevant, because both theory and practice suggest that cooperative economies produce more ambitious environmental policy (Bättig and Bernauer 2009; Bernauer and Böhmelt 2013; Dryzek 2005, 167). Although these are blunt measures, controlling for normative commitments and institutions at the national level could help reveal whether sink-based mitigation is primarily a product of domestic politics.

Explanatory Focus III: International Regime Logics

Carbon sinks have been at the heart of the international climate regime since the 1992 framework convention, which prescribed states to "promote and cooperate" in the "conservation and enhancement of sinks" (UNFCCC 1992, 12). To examine variation in state behavior with respect to CCS and REDD+ from an international relations perspective, this section considers power, norms, and self-interests as three variables of international regime dynamics. In terms of power, states' sensitivities to the international regime's normative pressure vary with each member's fundamental condition in the international system (Keohane and Nye 2012). According to this logic, small states are more exposed to external demands and may therefore follow the regime's call for mitigation action more closely, including its requests for sink-based mitigation. Then again, the major powers, being large and rich, may also be the ones with ample resources to test a broad array of mitigation measures on an experimental basis, including sink-based ones, without tying this to concrete mitigation commitments.

Moreover, signaling commitment to climate action may be important for *all* states that wish to avoid the consequences of openly disregarding what has become an international norm (Finnemore and Sikkink 1998). Pledging support for certain mitigation measures could represent a way of displaying a constructive attitude toward the global governance effort. Because both CCS and REDD+ are high-visibility topics within the regime, elaborated CCS and REDD+ policies could function as so-called *symbolic signaling* to other regime members. Such symbolic signaling behavior has been documented in climate policy before, such as in Germany's national legislation (Newig 2007) or Japan's post-Kyoto behavior (Tiberghien and Schreurs 2010). Although showing a commitment to international norms and regimes is not the same as reducing emissions, it may be equally important for political reasons.

Finally, in a narrower self-interest perspective, preferences for mitigation measures could follow from strict means-ends calculations (Sprinz and Vaahtoranta 1994; de Coninck and Backstrand 2011). If so, support for sink-based mitigation will be stronger if the national mitigation potential from such measures is greater. For example, producers of natural gas, the least carbon-intensive fossil fuel, would show less interest in sinks than producers of oil and coal (Tjernshaugen 2008). States with similar means-ends calculations are also likely to share views on other regime issues. Such patterns could be exposed by mapping states' formal and informal negotiation groups. For example, the so-called Umbrella group (notably including Australia, Canada, Japan, New Zealand, Norway, and the US) is reportedly the strongest proponent of both international carbon markets and offsetting using sinks (Gupta 2014). The Cartagena Dialogue is another informal constellation of states with a more ambitious mitigation agenda outside the formal negotiation groups. The effects from these international-relations logics are operationalized and tested in the following analysis.

Empirical Analysis

Data Selection and Measurements[3]

The dataset includes twenty-six "Annex I countries" for the 2007–2014 period. This group of industrialized states accepts a certain commitment to lead on mitigation because of their augmented capabilities and responsibilities (Gupta 2014). As potential frontrunners, their policy preferences may pave the way for global practices. Moreover, the argued comparability of CCS and REDD+ makes

3. Supplementary materials can be obtained from the author.

sense only from an industrialized country's perspective, because of these countries' funding role in REDD+. The comparison of similar units, all variations of capitalist democracies, helps improve the control of exogenous factors. However, not all relevant data may be captured at country-level resolution. The European Commission is an important provider of the EU's REDD+ funding, which presumably leaves less of a burden on national member governments. In some federal states, such as Canada, some CCS policies are anchored at the state level. Such imperfections are acceptable because the potential for cross-national trends is upheld.

Measuring Political Commitment to CCS and REDD+

Political commitment to CCS and REDD+ is measured with public budgets. The assumption is that more generous budgets reflect more ambitious policies. Contrary to the expenditure data, which could face practical constraints during implementation, budgetary data may effectively capture political ambition. To account for the relative differences in states' economic space for maneuvering, the budgetary data are divided by annual gross domestic product (GDP) per capita. A wealth-based denominator is appropriate because the rationale for the climate regime's grouping of so-called Annex I is that the historical responsibility and wealth there allow for more ambitious action. Because some of the annual data are of varying quality, countries' CCS and REDD+ scores are measured as one score for the 2007–2014 period. The CCS variable is constructed from two complementary sources. First, the OECD's basket measure for "CO_2 capture and storage" from the IEA Energy Technology RD&D Statistics dataset serves as a baseline measure (IEA Statistics 2015). However, an R&D-focused source insufficiently captures wider political dedication toward CCS, for governments also spend ODA and other types of public funding for the purpose (Roettereng 2016). To complete the picture, I communicated with governments and reviewed national policy documents to construct a second dataset. This resulted in national CCS figures with fewer zero values and more extreme variations than in the IEA data, but with a very similar trend (the bivariate correlation between the self-gathered and IEA data is significant at $p < 0.001$, coeff. = 1.274, $r^2 = 0.571$, standard error = 0.23). To transparently build on the available information, the IEA and self-gathered datasets are combined in one average score per country for the covered period. ZERO's database listing CCS projects per country is used for validity control (ZERO 2015). Political commitment to REDD+ is scored on the basis of states' pledges to the Voluntary REDD+ Database (VRD; FAO VRD 2014). Although the VRD's "voluntary" nature without third-party verification leads to inconsistencies in reporting, it is the most comprehensive database for REDD+ finance available (Norman and Nakhooda 2014). I traced all individual REDD+ project allocations back to the funding countries of origin and have summarized the states' total contributions. The dependent variables are summarized in Table 1.

Table 1
Distributions of Dependent Variables

Measures	*Description*	*N*	*Mean*	*Std. Dev.*	*Min.*	*Max.*
Continuous Measures						
CCS weighted*	Weighted cumulative CCS budgets from self-gathered and IEA data	26	8.46	14.62	0	43.77
REDD+ weighted*	Weighted VRD pledges	26	6.54	9.52	0	32.48
Zero CCS projects**	For validity control – Zero's CCS project database	26	5.85	8.99	0	37
Dichotomized Measures						
CCS proponents	Dichotomized CCS ranking from CCS weighted: >15.7 = 1	26	0.42	0.50	0	1
REDD+ proponents	Dichotomized REDD+ ranking from REDD+ weighted: >15.7 = 1	26	0.42	0.50	0	1
Sink proponents	Sums of CCS and REDD+ dichotomous scores	26	0.75	0.85	0	2
Zero	For validity control – Dichotomized Zero's CCS projects: >1 = 1	26	.5	.51	0	1
Categorical Measure						
Sinks score	Sums of rankings from CCS weighted and REDD+ weighted	26	26.96	14.42	5	51

*In millions of US$/GDP/capita/year ×1000, totals for 2007–2014; ** in number of projects per country.

Measuring the Independent Variables

Economy and energy statistics are derived from IEA/OECD, BP, World Bank, and UN statistics (BP 2014; IEA 2014; World Bank 2014). National political systems are mapped using the Comparative Political Data Set III (Armingeon et al. 2008). Variations in economic organization follow Hall and Soskice (2001). States' self-reported mitigation targets under the 2009 Copenhagen accord measure their unilateral climate ambitions (Buhr et al. 2012). The Comparative Climate Change Performance Index 2015 reports on national climate policy implementation (Blaxekjær and Nielsen 2014; Burck et al. 2015). National obligations under the second, 2012–2020 Kyoto commitment period (Kyoto II) indicate states' responsiveness to normative pressure from the international regime (UNFCCC 2012). The International Environmental Agreement database captures the effect from integration in wider multilateral environmental cooperation (Mitchell

2015). Population size measures the absolute country size (GDP is also controlled but has been omitted because of multicollinearity with population, which offers more intuitive coefficients). The group of control variables includes R&D funding per GDP, deficits in public budgets, ODA, and national forest cover. The independent variables are listed in Table 2.

Methods

The theorized explanations were examined in two steps. In step 1, the aim was to identify solid bivariate associations using two dichotomous distributions. Fisher's exact test was used to predict exact *p* values to this end (Lachapelle and Paterson 2013). This parsimonious approach holds the potential to transparently highlight relationships within a small sample. In step 2, ordinary least squares (OLS) regression models were run using continuous data. OLS regression coefficients indicate the linear direction and strength of correlated relationships while also taking interaction effects into account. However, this form of analysis requires particular caution because the data are heteroscedastic, which is common for cross-national policy analyses. Although the regression coefficients remain unbiased under such circumstances, standard tests of statistical significance may be unreliable. This is where the bivariate relationships offer analytical backing. Negative binomial regression could potentially overcome the distribution problems, but a simpler linear two-step approach helped stay on the transparent side of the "deadly sins in quantitative political analysis" that may follow from using overly sophisticated techniques on limited empirical materials (Schrodt 2013). To avoid models with underappreciated implications, no more than three well-understood variables were employed at a time to the current best-fitting OLS models (Achen 2005).[4]

To measure political support for CCS in a way that is comparable to support for REDD+, countries received corresponding quantile-based rankings from 1 to 26 from their weighted scores (N = 26, with 26 the highest score). For the bivariate analysis, to capture most of the variation in these measures, states were coded as CCS and REDD+ supporters if they ranked in the upper 40th percentile, equivalent to 15.7 or higher on the twenty-six-quantile ranking. States' *combined* carbon sink policy scores were thereafter grouped by summarizing the dichotomous REDD+ and CCS scores into "combined sink scores" of 0, 1, or 2. The threshold levels for the dichotomization of the independent variables are reported in Table 2. For the multivariate analysis, states' quantile-based CCS and REDD+ rankings were summarized as a means to construct aggregate "sink scores" from 1 to 52 (N = 26, with 52 as the highest score). These categorical measures do *not* capture the relative gap between each incremental step, but they suffice to indicate the coefficients' direction and relative contribution for a ranking within the sample.

4. In addition to visual inspection of the data, I focus on these two steps according to the advice that "provided they fit researchers' theoretical assumptions, there is no reason why inductive multivariate statistical methods should not be exploited by comparativists" (Shalev 2006, 297).

Table 2
Distributions of Independent Variables

Explanatory Focus	*Dependent Variable*	*Measure*	*N*	*Mean*	*Std. Dev.*	*Min. Value*	*Max. Value*	*Dichotomous Dist. (1)*
		Energy Political Economy						
Energy consumption	Fossil energy	% of total	26	75.24	16.30	32.62	94.53	>80
	Renewable energy	% of total	26	16.53	13.84	3.20	57.27	>20
Fossil energy production	Oil production	Million tons	26	27.54	76.11	0	349.83	>0
	Natural gas production	Million tons of oil equivalents	26	36.35	112.90	0	562.90	>0
	Coal production	Million tons	26	77.59	205.98	0	981.53	>0
	Fossil fuels exports share of GDP	% of merchandise exports	26	10.30	13.68	0.94	66.52	>10
		National Public Policy						
National institutions	Parliament	Dichotomous, Parl. = 1	25	0.64	0.49	0	1	1
	Federal state	Dichotomous, Fed. = 1	25	0.32	0.48	0	1	1
	Economic organization (LME/CME)	Dichotomous, LME = 1	21	0.45	0.47	0	1	1
National climate policy ambition (climate policy)	Unconditional national mitigation target under Copenhagen Accord	% change from shared baseline	26	16.62	8.98	−12.00	25.00	−20
	Climate Change Performance Index 2015	CCPI scores (0–100)	26	57.82	9.53	35.57	77.76	62.5

			International Regime Logics					
Power relations and normative signaling	Population	Millions	26	39.50	63.29	0.50	307.81	50
	GDP per capita	Per Head US$	26	39,097.58	13,327.79	16,647.90	84,821.70	40,000
	Obligation under Doha amendment to Kyoto Protocol 2013–2020	% change from 1990 baseline	26	15.09	8.45	0.00	20.00	<0
	International Environmental Agreements	No. of IEAs	25	158.42	41.01	93.38	263.88	150
Self-interests	Umbrella group	Dichotomous, Umb. = 1	26	0.23	0.43	0	1	1
	Cartagena Dialogue	Dichotomous, CD = 1	26	0.42	0.5	0	1	1
	EU member	Dichotomous, EU = 1	26	0.69	0.47	0	1	1
	Forest cover	% of land area	26	33.79	17.58	10.66	72.90	33
	Fossil energy production (as above)							
			Control Variables					
	Deficit size (Deficit/GDP)	% of GDP	25	−1.80	4.01	−10.27	11.75	>−1
	Human Development Index	HDI 2014 scores (0–1)	26	0.88	0.04	0.74	0.94	0.9
	Official Development Assistance	10^9 US$	26	4.69	6.21	0.06	28.17	>2
	R&D share of GDP	% of GDP	25	1.99	0.78	0.72	3.53	2

Results

The crucial first finding is the strong and positive relationship between CCS and REDD+; states that show strong support for one show similar support for the other. The dichotomous relationships are consistently significant at $p < 0.001$. The bivariate correlation between the continuous CCS and REDD+ measures is also significant at $p < 0.001$ (with coeff. = 1.04, standard error = 0.23, adj. r^2 = 0.44). Figure 1 shows that the categorical measures consequently also follow a strikingly linear pattern. In addition, the figure's horizontal and vertical lines at x = 15.7 and y = 15.7 indicate the threshold values for the dichotomous distributions. These show that nine countries—Australia, Canada, France, Germany, Italy, Japan, Norway, the UK, and the US—rank as both CCS and REDD+ proponents. Only Finland, the Netherlands, Poland, and Sweden appear as proponents of only one sink-based measure in these distributions. The rest score zero on both dichotomous measures. Additionally, when compared to ZERO's project counter, the CCS and REDD+ measures correlate well within the $p < 0.01$ level. Table 3 reports all bivariate relationships for the dichotomous distributions. For the multivariate analyses, all variables were run in numerous constellations. The multivariate results generally confirm the dichotomous relationships. Table 4 presents select

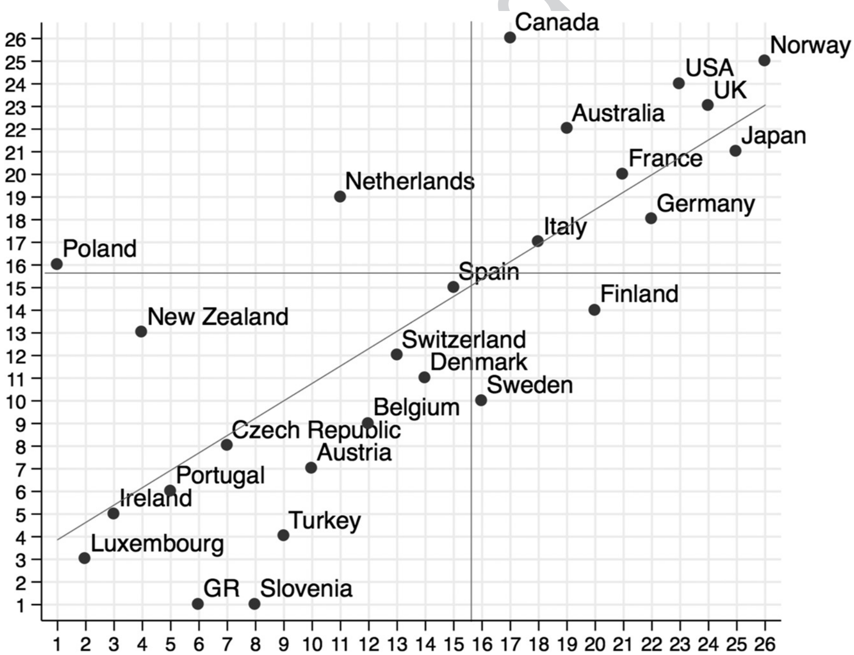

Figure 1

Categorical Rankings of CCS and REDD+ Scores

The x-axis covers REDD+ scores, and CCS scores are measured on the y-axis. The horizontal and vertical lines at x = 15.7 and y = 15.7 indicate cutoff values for the dichotomous distributions. The diagonal solid line is the regression line.

Table 3
Bivariate *p* Values for Fisher's Exact TestTB

	Carbon Sink Policy				*Energy Political Economy*						*National Public Policy*				
Explanatory Focus	*CCS and REDD+ Covariation*				*Energy Consumption*		*Fossil Energy Production*				*National Institutions*		*Climate Policy*		
Dependent Variable	*Sink Proponents*	*CCS Proponents*	*REDD+ Proponents*	*Zero*	*Fossil Energy*	*Renew.*	*Oil*	*Nat*	*Coal*	*Fossil Exports*	*Parl*	*Fed*	*LME*	*Cph.*	*CCPI*
Sink proponents	-	**0**	**0**	**0**	0.28	0.631	**0.006**	**0.001**	0.178	0.146	0.626	0.256	0.547	0.25	1
CCS	**0**	-	**0.001**	**0.001**	**0.045**	0.217	**0.021**	**0**	0.111	0.054	0.677	0.656	0.85	0.279	0.658
REDD+	**0**	**0.001**	-	**0.015**	0.692	1	**0.021**	**0.043**	0.428	0.348	0.677	0.656	1	0.279	1

	International Regime Logics								**Control Variables**			
	Power Relations and Normative Signaling				*Self-Interest*				*Nontheorized Alternative Explanations*			
	Population.	GDP/cap	KyotoII	IEA	Umb.	CD	EU	Forest	Deficit	HDI	ODA	R&D/GDP
Sink proponents	**0.006**	0.866	0.189	0.28	**0.02**	0.128	0.105	0.874	1	0.629	**0.002**	0.866
CCS	**0.021**	0.692	0.348	0.692	0.054	0.109	0.218	0.246	0.414	0.218	**0.005**	1
REDD+	**0.021**	0.692	0.348	0.233	0.054	0.109	0.218	1	1	0.697	**0.005**	0.233

Significant values are bold ($p > 0.05$).

Q2

Table 4
Selected Multivariate Regressions

Model No: Dep. Var.		*1: Sink Score*	*2: CCS Weighted*	*3: REDD+ Weighted*	*4: Sink Score*	*5: Sink Score*	*6: CCS Weighted*	*7: REDD+ Weighted*
Fossil energy production	Oil	**0.24** *	**0.45** ***	**0.15** *	**0.07** **		**0.44** ***	
		(0.12)	(0.08)	(0.09)	(0.02)		(0.07)	
	Nat.	−0.11	**−0.22** ***	−0.07			**−0.22** ***	
		(0.08)	(−0.06)	(−0.06)			(0.49)	
Climate policy	CCPI	−0.12	−0.25	−0.06	**−0.76** **		**−0.43** **	
		(0.41)	(0.36)	(0.27)	(0.23)		(0.16)	
	Cph.	−0.31	**−0.67** *	0.09				**0.39** **
		(0.43)	(0.38)	(0.29)				(0.19)
Self-interests	CD	**11.57** **	5.16	4.42				
		(4.63)	(3.88)	(3.53)				
	Umb.	**14.37** **	**24.48** ***	**8.60** **		**19.80** ***		**18.23** ***
		(5.43)	(4.55)	(4.14)		(4.05)		(3.80)
Power relations and normative signaling	Population	0.043	0.012	**0.06** *				
		(0.03)	(0.04)	(0.03)				
	KyotoII	**−1.18** ***	**−1.42** **	−0.36				
		(0.26)	(0.14)	(0.243)				
	IEA	**0.26** ***	**0.15** **	**0.125** ***	**0.25** ***	**0.20** ***		**0.14** ***
		(0.05)	(0.06)	(0.04)	(0.05)	(0.04)		(0.03)
Alternative explanations	ODA	**1.60** ***	**1.21** **	**1.05** ***		**0.69** **		
		(0.34)	(0.41)	(0.23)		(0.28)		
	N				25	25	26	25
	Adj. R^2				0.61	0.75	0.75	0.56

Solid horizontal lines separate thematic models *for* columns 1–3. Standard errors appear in parentheses below coefficients. Columns 4–7 show example best-fit models. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.

results. Let us consider the dichotomous and multivariate results in combination, in the order of the theorized energy political economy, public policy, and international relations variables.

First, oil *production* is a strong and consistent explanatory factor for all dependent measures. In Table 4's model 1 on fossil energy production, an additional 1 million tons of CO_2 equivalents from oil production boosts a state's "sink score" by 0.24. However, the other fossil fuels do not show similarly consistent patterns. For natural gas, this is because the major natural gas producers Denmark and the Netherlands score relatively low on the dependent measures, whereas strong sink proponent the UK has relatively little such production to show. For coal, producers such as Greece, Turkey and the Czech Republic rank toward the bottom of the dependent measures. However, make no mistake, with Japan and France as exceptions, all the top sink proponents produce coal or gas or both *in addition* to oil. The lack of positive and significant multivariate correlation for natural gas can be explained by the relatively small sample and interplay effects with oil. On a bivariate basis using continuous data, natural gas is positively associated with all dependent measures.

Second, no patterns tie preferences for sink-based options with certain domestic decision-making systems or models of economic organization. Federal (Canada), unitary (Japan), presidential (US), and parliamentary (UK) systems, as well as both cooperative (Norway) and liberal (Australia) economies, may produce more ambitious sink policies than the rest. When controlling for unilateral climate policy ambition, nonsignificant but consistent results indicate that *lowered* ambitions are tied to more ambitious sink policies (Table 4, models 1–4, 6). Although this potential attribution was not confirmed in the dichotomous analysis, it rules out that higher climate political ambitions lead to stronger support for CCS and REDD+.

Third, being large in terms of population is a significant factor in the bivariate analysis (Table 3). However, when assessing population as a continuous measure and in multivariate configurations, this relationship is nonsignificant and has only limited influence on the dependent variables (Table 4). This suggests that large states, defined as those with more than 50 million inhabitants, are more supportive of sink-based measures, although there is no linear relationship between size and sinks across the spectrum. Instead, augmented participation in international environmental governance (IEA) has a significant and positive association with more ambitious carbon sink policies throughout all models (Table 4). This also applies when accounting for national obligations under the 2012–2020 climate regime, where a more ambitious Kyoto II target is negatively associated with the combined sink score and with CCS (Table 4, models 1–3). When splitting states into their negotiations groups, the Umbrella and Cartagena Dialogue members are clearly more supportive of sink-based measures (Table 4, models 1–3). Model 1 indicates that the states with both Umbrella and Cartagena Dialogue memberships, counting Australia, Canada, New Zealand, and Norway, score a remarkable 25.94 points higher than the rest on the joint CCS and REDD+ "sink score." The EU group, however, is mixed. A handful of countries stand out as CCS and REDD+ proponents, notably the UK and Germany. Others, such as Ireland and Greece, score very low. As expected following the means-ends logic, some states with more natural gas seem less interested in sink-based solutions.

The multivariate best-fit models (Table 4, models 4–7) highlight a few distinct factors that capture most of the variation on the dependent variables. For the combined sink score in model 4, controlling for oil production, climate political performance, and integration in global environmental policy-making is sufficient to account for 61 percent of the variation (adjusted $r^2 = 0.61$). The model suggests that the national climate policy score (CCPI) is negatively correlated with the CCS and combined sink measures. Model 5 illustrates how effectively controlling for the interest-based negotiations groups captures states' carbon sink policies, with Umbrella group members scoring an additional 19.8 points on the sink score. The model also indicates that states, by boosting their ODA budgets by an additional US$ 1 billion for the 2007–2014 period, increase their combined sink score by 1.6. For CCS, model 6 highlights the link between fossil energy and national climate policy. It suggests that accounting for oil and gas production and climate policy performance captures 75 percent of the variation (adjusted $r^2 = 0.75$). Model 7, the example best-fit model for REDD+, displays how a stronger unilateral mitigation ambition, deeper integration in global environmental governance, and Umbrella membership capture more than half of the variation (adjusted $r^2 = 0.56$). The discrepancies between the CCS and REDD+ models highlight that there is no *single* uniform distribution of three explanatory factors that equally captures the variation on the two carbon sink measures. The interpretation is that CCS is more related to fossil energy production and that REDD+ is more attached to international climate policy in terms of mitigation targets and coordination.

Finally, Canada and Norway account for disproportionate shares of the variation in the continuous dependent variables. Therefore, the best-fit models were rerun without these two countries for robustness checks. All results were confirmed, with the exception that a more ambitious unilateral climate policy ambition no longer was significantly associated with a higher REDD+ score. This may be explained by Norway's ambitious Copenhagen target and exceptional position in REDD+ finance. Beyond the theorized variables, no link was found to tie CCS policies to countries with higher relative R&D expenditures, which is contrary to an earlier finding (Tjernshaugen 2008). As expected, countries with higher ODA budgets spend more on REDD+. It is more remarkable that a higher ODA budget is also associated with a higher CCS budget (Table 3, $p < 0.01$, and Table 4, models 1, 2, 5).

Discussion

Studying the Politics of Carbon Sinks Makes Sense

This study's empirical premise, the finding that the same states consistently show stronger support for *both* CCS and REDD+, encourages fresh thinking on the politics of mitigation measures. The immediate implication is that it makes sense to label CCS and REDD+ as comparable carbon-sink-based measures when studying industrialized countries, underpinning the argument that similar types of mitigation measures may serve similar political functions. The results presented here suggest that sinks are sinks in climate politics, regardless of their origin, *and* that sinks represent more attractive options for certain groups of states, highlighting how political science arguments can be pursued in empirical climate policy analysis. If it does not pinpoint *exactly* how and why for individual states, the analysis sheds light on some interesting patterns that suggest under which circumstances carbon sinks may represent attractive political solutions. From the theorized energy political economy, public policy, and international relations arguments above, what stands out are three concrete findings that in combination point to the strategic significance of carbon sinks. First, sink-based mitigation measures are products of climate policy, but not of higher mitigation ambitions. Second, fossil energy production leads to support for sink-based measures. Third, support for sink-based mitigation measures is preferred by the large and the resourceful. How, then, may these results be interpreted?

Making Sense of the Politics of Carbon Sinks

Starting by coupling sinks to climate policy, we have seen in the data a statistical disconnect or potential negative relationship between an ambitious mitigation target and firmer support for sink-based options. This prompts the interpretation that states taking part in a supernational carbon cap are accepting a more ambitious mitigation target and may not see themselves as being in "need" of sinks. Comparing major coal producer Turkey, with its low support for sinks, to coal-producing EU neighbor Greece, displaying an even lower concern for sinks, makes two cases in point. Although the former has a nonexistent mitigation target, it is arguably unlikely that the latter would accept taking part in such a firm mitigation target if it were not for the union-wide nature of the EU's commitment. While it has only halfheartedly promoted sink-based mitigation, the EU group mainly trusted to its trading scheme to meet its objective for the 2007–2014 period. Correspondingly, the EU block has shown reluctance toward using VERs from REDD+ and other global market-based mechanisms for this purpose. As compared to that of the EU group, most other states' mitigation targets fall short, but this has not hindered support for sink-based mitigation. This is true in the US, for example, where federal climate policies are few but financial support for REDD+ is mobilized as *forest* development assistance (via USAID and the US Forest Service), and support for CCS is labeled an *energy* policy. In Australia, the 2009 "CCS Flagship Program" was maintained even though a change of government in 2013 reduced the country's climate commitments.

These results suggest that affluent fossil energy producers outside shared carbon caps face different climate political realities than other countries, and that this is because of petroleum extraction's importance to the political economy. In addition, the necessary expertise for doing CCS has been provided by the petroleum industry in many places, as can be seen with CO_2 reinjection in the US. The theoretical inference is that different *types* of carbon lock-in have different climate political consequences. Equally, from an energy *security* perspective, advocating CCS is reasonable if the state's interest is to maintain demand in a carbon-restrained future. This reasoning was used by the Norwegian government when urging its petroleum industry to embrace CCS as being crucial for continued growth. Possibly fulfilling the same function, REDD+ offers a nearly inexhaustible and continuous mitigation potential that in many cases outweighs emissions from national petroleum production. The latter consideration would become especially cogent if VERs from REDD+ in the future became part of an international offsetting scheme, which some non-EU petroleum producers aim for. Beyond those with fossil energy interests, mitigation targets, or Umbrella membership, the group of large states, including those with few fossil resources (France and Japan), are those most supportive of carbon sinks. This is evidence for the idea that the major powers (Australia, the US, Canada, and Japan) engage more broadly in global climate politics, even without ambitious mitigation targets. The elaborated capacities and aspirations that follow from being large seem to open a wider menu of climate political alternatives, including support for sink-based mitigation measures. Small-state carbon-sink-proponent Norway is the exception to this picture.

What It Really Means: Sinks as Signals

When considering that REDD+ represents international climate governance *par excellence*, it may still seem puzzling that the large and, in a Kyoto II context, "unilateral" CCS countries tend to be the same as the "north-south cooperative" REDD+ advocates. This apparent contradiction may be resolved if what *really* matters is to be recognized as responsibly participating in global climate politics, without abandoning fundamental energy interests. Even if these states do not take on sweeping mitigation targets, they acknowledge the importance of signaling commitment to the climate regime's normative purpose. We could therefore interpret strong support for CCS and REDD+ as a bridging exercise in which harmonization of material fossil energy interests and the climate change mitigation agenda is sought before external audiences. On the one hand, states may not wish to be coordinated by the international climate regime to a degree that impacts national economic structures. On the other, states acknowledge climate change mitigation as an international norm. States may therefore wish to signal their normative alignment by demonstrating support for mitigation measures that hold significant potential without harming their economic interests. CCS and REDD+ could serve this purpose. It fits this picture, in which carbon sinks offer pragmatic mitigation strategies, that the allegedly more ambitious Cartagena Dialogue members (including Australia, Canada, France, Germany, Norway, and the UK) are consistently more supportive of sink-based mitigation. Recall also that high participation in wider international environmental governance is a consistent predictor of more ambitious carbon sink policies, which also indicates a general commitment to international cooperation. Because ODA also represents a normative commitment to global good, this interpretation may also explain the link between generous CCS and ODA budgets. The political function of sink policies as a means of symbolic signaling may also be illustrated by the fact that most REDD+ funding is from ODA. Such motives or effects could also relate to the political feasibility of certain mitigation measures, such as sink-based ones.

However, if the aim is to move beyond a signaling pattern, it is hardly reassuring that a small state such as Norway holds such a prominent role in the advancement of two allegedly crucial mitigation measures. When a small state accounts for a disproportionate share of the total allocations, this indicates that the large states, in reality, are lukewarm. Although they face institutional, technological, and other challenges as well, dismissing the interpretation that CCS and REDD+ serve a primarily symbolic function would require that the actual mitigation results reach a level that better corresponds to the promised problem-solving potentials that form the basis of their legitimacy as mitigation measures.

The Future of Carbon Sinks in Global Climate Politics

This study covers only an early stage of states' sink policy implementation. Still, developments since the 2015 Paris Agreement have indicated that the results presented here remain relevant. For example, of the countries in this dataset, only Canada and Norway specifically report CCS as being an important mitigation measure in their Nationally Determined Contributions. The group of states mentioned as REDD+ supporters in this study have been equally at the forefront of new REDD+ initiatives. However, the post-Paris negotiations and other multilateral efforts may change the incentives embedded in REDD+ and the modalities of CCS, such as the status of VERs and the legality of trans-border CO_2 transportation. Such conceptual changes could alter these measures' political implications. As an example, an important development since the period covered by this study has been a shift toward framing CCS as a solution for industrial smokestacks, which could disentangle the concept from fossil energy production. One could also foresee shifts in the economics of CCS if planning were increasingly to assume shared transportation and storage instead of single-site projects. For REDD+, where the current focus is on tropical deforestation, some may wish to move international attention toward reforestation and afforestation. The current emphasis on rainforests in REDD+ may also see competition from other types of biomass and policy labels, such as "blue carbon," a term often used to refer to mangroves.

Thus, we are likely in the infancy of global carbon sequestration politics. One important driving force is the Paris regime's unsettled decisions on the relationship between carbon from fossil sources and biological sinks (Dooley and Gupta 2016). Another is the Paris regime's request for increasing national mitigation ambitions over time, despite the structural standing of fossil fuel production in some political economies, which this study also confirms. This will likely increase the political attention given to sinks as bridging options. Additionally, a rising demand for "negative emissions" can also only be met through the use of sinks, potentially including by sequestering carbon from biomass energy production using CCS (BECCS). Researchers warn that this will have significant consequences for the biosphere, prompting political answers at national and international levels (Anderson and Peters 2016). All of this suggests that the politics of mitigation measures and the politics of carbon sinks will only become more important areas of study. This article marks the first comparative investigation into the interlinkages of the different sink-based concepts, CCS and REDD+, offering a useful contribution toward that end.

Conclusions

This inquiry into the politics of CCS and REDD+ in the pre-Paris years sheds light on industrialized states' preferences for sink-based mitigation measures. The most intriguing finding is the close covariation between CCS and REDD+ proponents—they are the same. This supports the assumption that the CCS and REDD+ concepts, as carbon-sink-based mitigation measures, serve comparable political functions in similar settings. On the basis of insights from political economy, public policy, and international relations theory, the findings expose the structural prominence of fossil energy production concerns in climate policy and how sink-based options represent an alternative for states that aim to bridge climate and energy interests. Interestingly, the large and resourceful countries are generally the ones pursuing this strategy, but only at a limited level in the studied period. This tempts us to the conclusion that supporting sink-based mitigation measures serves an important political function as a means for signaling commitment to climate change mitigation as an international norm for the covered period. The study demonstrates that empirically informed "triply engaged" comparative climate policy analysis is demanding but doable. Similar investigations could focus on other mitigation measures, study other polities, and further incorporate ongoing post-Paris regime developments.

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