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Screening or constraining? The relationship between participation and target achievement in transboundary air pollution treaties

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Abstract

Enforcement and management scholars alike expect that countries participating in an international agreement will more likely achieve predetermined targets than nonparticipating countries will. The management school ascribes this expected association to a constraining effect of the treaty; the enforcement school ascribes it to a screening effect. If the latter conjecture is correct, the association between participation and target achievement should significantly weaken (or even vanish) when controlling for targets' ambition level and other confounding factors. We test this hypothesis on a new dataset comprising three protocols under the Convention on Long-Range Transboundary Air Pollution (CLRTAP). Our results suggest that the positive association between participation and target achievement is robust to controlling for confounding factors; hence, our data suggests that these CLRTAP protocols have indeed constrained participating states.

Previous Next

Keywords

International environmental agreements; Constraining; Screening; CLRTAP; Participation; Target achievement

1. Introduction

At least since the 1990s, the literature on international environmental governance has seen a division between two main schools – the enforcement school and the management school – concerning the importance of enforcement for achieving compliance with ambitious targets under international agreements. In this paper, we draw on a new dataset to conduct a test that enables us to determine which school receives most support in the case of three protocols regulating transboundary air pollution in Europe.

Our point of departure is the observation that scholars from the enforcement and management schools alike expect a positive association between participation and target achievement in international agreements; participating countries should be more likely than nonparticipating countries to fulfill predetermined targets. In the words of Von Stein (2005: 611), "signatories engage in compliant behavior more than do nonsignatories." However, while the management school ascribes this expected association to treaties' constraining effects, the enforcement school ascribes it to a screening effect, that is, states will mostly join treaties requiring little or no costly behavioral change (e.g., Downs et al., 1996; Barrett, 2008).

The literature on international compliance and target achievement is remarkably rich. Some scholars have delineated 'compliance' from related concepts such as 'implementation' and 'effectiveness' (Young, 1992; Bernauer 1995). Others have offered general explanations for why countries meet their international commitments (or not), highlighting factors such as legitimacy, capacity, costs, obedience, and norms (Franck, 1990; Chayes and Chayes, 1993; Downs et al., 1996; Koh, 1997). Yet others have conducted empirical studies of countries' adherence to agreements concerning issues such as border disputes, war crimes, human rights, trade, the environment, and more (e.g., Naurin and Stiansen, 2020; Rickard, 2010; Simmons and Danner, 2010).

We contribute to this last strand of literature by examining empirically whether parties are more likely than relevant nonparties to meet their predetermined emission targets under a set of treaties regulating transbounday air pollution in Europe. Our research draws on a new data set covering three of the eight protocols under the Convention on Long-range Transboundary Air Pollution (CLRTAP).[1] As explained in section 4, studying these CLRTAP protocols entails major advantages for our purposes.

As far as we know, we conduct the first study directly comparing participating and nonparticipating countries' achievement of predetermined targets under international treaties. Our findings challenge those of many previous econometric studies of CLRTAP protocols, which have found little (if any) constraining effect of these treaties and therefore would seem to support the enforcement school (Ringquist and Kostadinova, 2005; Aakvik and Tjøtta, 2011; Vollenweider, 2013). In contrast, our results largely support the management school.

Our research differs from previous studies both concerning the data and regarding the dependent variable. While most extant studies focus on a single protocol,[2] we study three protocols jointly. Moreover, our data set includes the Gothenburg Protocol's targets concerning non-methane volatile organic compounds (NMVOC) and ammonia, which were not included in any of the previous studies mentioned above. Finally, while these previous studies use emissions as the dependent variable, we focus on target achievement, which seems more immediately in line with the two schools' contested theorizing.

Our research also relates to scholarship concerning how much different types of treaties screen states. Examples include Dai and Tokhi (2016), who find that states' reluctance to commit to demanding treaties is less pronounced for environmental treaties than for human rights treaties (see also Simmons and Danner 2010).[3] Moreover, some studies report that countries with good human rights records are more prone to participate in human rights treaties (e.g., Landman, 2005), while others contend that governments with poor records participate at least as often as those with good records (e.g., Hathaway, 2007). Finally, Dai and Renn (2019) find that countries more often self-select into optional protocols than into conventions, which are less likely to contain deep commitments. This last result suggests that screening is particularly likely to be associated with treaties of the type we study here.

2. Theory and hypotheses

A main motivation for countries to participate in IEAs is their provision of benefits in the form of avoided damage from pollution.[4] Other things being equal, countries are therefore more likely to participate if a treaty provides greater environmental benefits (e.g., Perrin and Bernauer, 2010). However, because air pollution crosses borders, CLRTAP protocols involve externalities that create incentives for free riding.

The two schools agree that participating countries generally fulfill their treaty commitments, and that enforcement has hardly played any role in achieving that record (Chayes and Chayes, 1993; Downs et al., 1996).[5] However, they disagree over the sources of this tendency of states to fulfill their commitments even without enforcement. The management school argues that states have a "general propensity to comply" rooted in concerns about efficiency, national interests, and, most importantly, regime norms such as *pacta sunt servanda*: "People, whether as a result of socialization or otherwise, accept that they are obligated to obey the law. So it is with states" (Chayes and Chayes, 1993: 185). Hence, the management school expects that norms will motivate participants to endeavor to fulfil their commitments, even when doing so is costly. However, nonparticipants are not subject to the same normative pressure. This difference in normative pressure results in a positive association between participation and (costly) target achievement.

In contrast, the enforcement school links this positive association to a screening effect. Countries will unlikely join treaties they expect to violate (Downs et al., 1996: 383);[6] hence, countries' ratification decisions are endogenous to their expectations regarding target achievement (Von Stein, 2005: 611). Countries that would face deep commitments (i.e., commitments significantly beyond what they would implement in the absence of the agreement) will often decline to ratify, meaning that participating countries will mostly have commitments close to BAU. Treaties will therefore typically cause little change in the behavior of participating countries. However, they will also cause little change in the behavior of countries with deep commitments because these states will likely decline to ratify and largely ignore their targets. In short, the enforcement school expects parties and nonparties alike to essentially continue BAU behavior. Moreover, BAU behavior will imply high achievement of pre-determined targets by parties (which mostly have shallow targets) and low target achievement by nonparties (which mostly have deeper targets yet largely ignore them). Per the enforcement school, this behavior explains the positive association between participation and target achievement.

Note that this reasoning is consistent with the possibility that countries might negotiate targets that simply codify already planned reductions due to non-treaty forces (e.g., domestic politics). Such targets would not require significant and costly behavioral change compared to what the participating countries would have done in the treaty's absence.[7]

In summary, both schools expect the following hypothesis to hold:

H1

Participating countries are more likely to achieve predetermined emission targets than nonparticipating countries are.

However, the two schools differ concerning the expected effect on the association between participation and target achievement of controlling for targets' ambitiousness. According to Downs et al. (1996: 383), we must "control for the depth of cooperation". The assumption is that states will unlikely ratify an agreement under which they would face a challenging (and therefore costly) target. Moreover, absent enforcement states will also unlikely fulfil ambitious targets – regardless of whether they participate or not. Therefore, per the enforcement school, the expected positive association between participation and target achievement constitutes a spurious effect that should vanish when controlling for ambition and other confounders.

The management school agrees that target depth might influence target achievement negatively, because capacity constraints could prevent fulfilment of deep commitments. However, for the management school, state behavior is more a matter of norms than of benefits and costs; hence, it leads us to expect little (if any) influence of commitment depth on participation. When a commitment is made, the behavioral drivers change: "When nations enter into an international agreement (…), they alter their behavior, their relationships, and their expectations of one another over time in accordance with its terms" (Chayes and Chayes 1993: 178). Per the management school, therefore, the positive association between participation and target achievement is causal rather than spurious:

H2

The positive effect of participation on target achievement persists even when controlling for the targets' ambition levels and other confounding variables.

Support for H1 might be interpreted as support for both schools' conjectures and therefore cannot serve to discriminate between them. In contrast, H2 is compatible with a constraining effect but *not* with a screening effect. Hence, we interpret support for H2 as support for the management school's conjecture. Similarly, we interpret *lack* of support for H2 as support for the enforcement school's conjecture.

Finally, the enforcement school's strong emphasis on the depth of cooperation could also be interpreted as a basis for expecting the association between participation and target achievement to be weaker for deeper than for shallower targets. Thus, we also test a third hypothesis, which posits an interaction effect between participation and ambition on target achievement:

H3

The positive effect of participation on target achievement is weaker, the more ambitious the targets for emissions reductions.

We interpret support for H3 as support for the enforcement school, while we interpret *lack* of support for H3 as support for the management school.

Table 1 summarizes our three hypotheses as well as some other conjectures proposed (or opposed) by each school.

Table 1. Conjectures and hypotheses supported (+) or not (−) by the two schools.

	Enforcement school	Management school
Countries generally fulfill their treaty commitments	+	+
Enforcement has played little role in achieving the high compliance rates	+	+
States tend to accede treaties with deep commitments	–	+
States do their best to meet deep commitments even without enforcement	–	+
Participating countries are more likely to achieve predetermined emission targets than nonparticipating countries are (H1)	+	+
The positive effect of participation on target achievement persists even when controlling for the targets' ambition levels and other confounding variables (H2)	–	+
The positive effect of participation on target achievement is weaker, the more ambitious the targets for emissions reductions (H3)	+	–

3. Empirical setting: transboundary air pollution and its political solutions

The 1979 adoption of the CLRTAP[8] by a group of (mainly) European states responded to the emerging scientific consensus that air pollutants such as sulfur dioxide (SO_2) cross borders and harm distant environments. The CLRTAP did not, however, entail economically costly commitments (Hanf, 2000). By 1983, when the "first wave" of states entering the CLRTAP ended, 25 states plus the European Union (EU) had ratified,[9] accepted, or approved the Convention. By 2023, CLRTAP parties totaled 51.

National emissions targets provided by a series of protocols are considered CLRTAP's main regulatory elements (Wettestad, 2012). These targets are formulated either as a general requirement that every party must reduce its emissions by the same specified percentage or as a set of specific targets varying across parties. In both cases, a deadline is specified.

By reducing emissions of four pollutants (Table 2), the CLRTAP protocols in our data set aim to solve three interconnected environmental problems. First, emissions of SO_2 and nitrogen oxides (NO_x) *acidify* water and soil, harming plants, humans, and animals. For instance, acidification may cause lethally low pH levels for fish and fry.

Table 2. Three CLRTAP protocols, with deadlines and regulated substances.

Protocol	Year of adoption	Deadline year(s)	Regulated substance(s)
Helsinki	1985	1993	SO_2
Oslo	1994	2000, 2005 (2010)	SO_2
Gothenburg	1999	2010	SO_2, NO_x, NMVOC, ammonia

Second, together with NOx, non-methane volatile organic compounds (NMVOC) cause *ground-level ozone*, which may aggravate respiratory diseases. While fossil-fuel combustion in large industrial and power plants causes both SO_2 and NO_x emissions, road and sea transport also constitute major sources of NO_x and NMVOC (Hanf, 2000). Finally, over-fertilization following agricultural ammonia emissions may lead to *eutrophication*, causing algae overgrowth and habitat loss for other species.

All three protocols studied include national emissions targets. First, the 1985 Helsinki Protocol obliged each party to reduce SO_2 emissions by at least 30% between 1980 and 1993. Second, the 1994 Oslo Protocol provided country-specific SO_2 emissions targets for 2000, 2005, and 2010.[10] Finally, the 1999 Gothenburg Protocol included country-specific targets (deadline year 2010) for SO_2 as well as NO_x, NMVOC, and ammonia.

The negotiation and formation processes of the three protocols follow the same pattern. Consider Oslo. Because of the approaching deadline of Helsinki, CLRTAP members began negotiating a second SO_2 protocol in 1992. The process of arriving at emissions targets was not only driven by political considerations; the individual targets were also influenced by scientific considerations concerning variations in emissions diffusion patterns and ecosystem exposure. Specifically, scientific bodies under CLRTAP have developed the "critical loads approach", which suggests stricter reductions of emissions that reach vulnerable ecosystems than of emissions causing less harm (Hanf, 2000; Tuinstraa et al., 2006). Hence, national emissions targets are to some extent exogenous to states' preferences. A protocol – including mutually agreed-upon national emissions targets – was finally adopted in Oslo in June 1994 and then opened for ratification. Thus, each state's ratification decision was made in full awareness of the protocol's contents, including the emissions targets.

Table 2 summarizes some core aspects of the three CLRTAP protocols studied here.[11]

4. Data

Studying our three CLRTAP protocols entails major advantages for our purposes. First, all three protocols comprise quantified emissions reduction targets with a specified deadline. This feature enables us to measure target achievement (as well as failure to meet targets) *precisely*.

Second, unlike many or even most other treaties, the three CLRTAP protocols in our data set specify emissions reduction targets also for nonparticipating countries, that is, also for CLRTAP members that did not ratify the protocol concerned. This feature enables us to measure target achievement even for a set of nonparticipating countries.

Third, the fact that the three CLRTAP protocols specify targets also for nonparticipating countries creates a rare possibility to control for commitment depth (i.e., the size of the required emissions reductions) across participants and nonparticipants. Such control obviously requires available targets also for the control group. While measuring commitment depth is notoriously challenging (e.g., Isaksen, 2020; Von Stein, 2005), our ambition-level variable captures heterogeneity in the size of the required emissions reductions. A potential weakness is, however, that it may not capture variations concerning emissions reductions (or increases) already underway when a protocol was adopted.

Finally, our data set displays substantial variation on the participation variable. Although several CLRTAP members have ratified all three protocols studied, many others have declined to become a party to at least one, and some even opted out of more than one. Table 3 shows all countries that participated in at least one of the three protocols.

Table 3. Participants in the Helsinki, Oslo, and Gothenburg protocols.

	Helsinki	Oslo (target year 2000)	Oslo (target year 2005)	Gothenburg
Austria	Yes	Yes		
Belarus	Yes			
Belgium	Yes			Yes
Bulgaria	Yes			Yes
Croatia		Yes	Yes	Yes
Cyprus				Yes
Czech Rep	Yes	Yes	Yes	Yes
Denmark	Yes	Yes		Yes
Finland	Yes	Yes		Yes
France	Yes	Yes	Yes	Yes
Germany	Yes	Yes	Yes	Yes
Greece		Yes	Yes	
Hungary	Yes			Yes
Ireland		Yes		
Italy	Yes	Yes	Yes	
Latvia				Yes
Lithuania				Yes
Liechtenstein		Yes		
Luxembourg	Yes	Yes		Yes
Netherlands	Yes	Yes		Yes
Norway	Yes	Yes		Yes
Portugal				Yes
Romania				Yes
Slovakia	Yes	Yes	Yes	Yes
Slovenia		Yes	Yes	Yes
Spain	Yes	Yes		Yes
Sweden	Yes	Yes		Yes
Switzerland	Yes	Yes		Yes
UK		Yes	Yes	Yes
Ukraine	Yes			

Our data set includes 198 observational units, each of which refers to a country's emissions target for a particular substance in a particular protocol. Hence, our observational units may be termed country-protocol-substances.

Because of these four features, our data set allows us to assess whether participating countries are more likely to achieve predetermined targets than nonparticipating countries are and if so, whether this positive association persists even after control for confounding variables.[12]

5. Definitions and operationalization

5.1. Dependent variable

We define target achievement as the degree to which a country meets an emissions target. For participating countries, target achievement is synonymous with compliance; however, because the latter term is awkward for non-participating countries, we consistently use the former term. None of the three CLRTAP protocols in our data set includes any provision that might relieve a party from its obligation to meet its emissions target for any of the four pollutants studied. Hence, participating countries have a legally binding obligation to fully meet their targets by the specified deadline. Therefore, we consider a state as fully achieving its target if and only if its deadline-year emissions did not exceed its target.

We use two operationalizations of the dependent variable – one dichotomous, one continuous. The dichotomous variable scores 1 if the emissions target concerned was fully met by the deadline, and 0 otherwise. In contrast, the continuous variable measures – by the time of the deadline – the relative distance between a country's target and its actual emissions. For instance, in 2010 France's actual NO_x emissions were 27.5% higher than its 2010 target under Gothenburg. The Gothenburg-France-NO_x unit therefore scores −0.275 on our continuous dependent variable. On the dichotomous dependent variable, it scores 0. All emissions data stem from the Centre on Emission Inventories and Projections (CEIP) database (CEIP, 2015). Established under the CLRTAP, CEIP collects emissions data of numerous pollutants, including those regulated by the protocols studied.

5.2. Independent variable

We count as participants countries that became parties to the protocol concerned no later than the year prior to the deadline year. For instance, Sweden ratified the Helsinki Protocol in March 1986, that is, well before the protocol's 1993 deadline. Thus, we code Sweden as a Helsinki participant. In contrast, we count as nonparticipants countries for which the protocol concerned specifies an emissions target, but which did not ratify (by the year before the deadline year).

As mentioned, two protocols (Oslo and Gothenburg) specify individual (country-specific) targets. Hence, nonparticipants to Oslo are states that have an individual emissions target under Oslo but declined to become a party. For instance, Belarus is one of 32 CLRTAP members for which Oslo specifies a national SO_2 target. Because Belarus never ratified Oslo, we code it as a nonparticipant to this protocol.

One protocol included in our data set (Helsinki) obliges all parties to reduce their emissions by a flat rate of 30% below 1980 levels by 1993. In Helsinki's case, we define as nonparticipants states that were CLRTAP members when Helsinki was adopted and yet declined to ratify it. For instance, the UK, a CLRTAP party since July 1982, never ratified Helsinki. We therefore code the UK as a Helsinki nonparticipant.

Our operational participation variable simply scores 1 for countries ratifying the protocol concerned no later than a year before its deadline for target achievement. Similarly, it scores 0 for countries not ratifying in the year before the deadline year or earlier.

5.3. Control variables

We operationalize our primary control variable, *ambition level* (commitment depth), as a country's emissions level *when the protocol was adopted* divided by its emissions target. Thus, the lower (deeper) the target relative to the emissions level at the time of adoption, the higher its ambition. Consider again France's NO_x target under Gothenburg. France's 1999 NO_x emissions were 92% higher than its 2010 NO_x emissions target. Therefore, the Gothenburg-France-NO_x unit in our data set scores 1.92 on the ambition-level variable.

Some scholars hypothesize that state capacity – states' ability to act – is an important determinant of target achievement (e.g., Chayes and Chayes, 1993; Börzel et al., 2010). Because state capacity might also influence participation decisions and the ambition level of emissions targets, we include as a control the World Bank's (2017) Government Effectiveness Indicator[13], which measures the quality of public services, bureaucracies, as well as policy formulation and implementation processes.

EU directives targeting air pollutants have been in force since the 1980s (Wettestad, 2012). For instance, the National Emissions Ceilings (NEC) Directive included national caps for all four pollutants studied here. Because these directives might influence both target achievement and participation decisions (Tallberg, 2002), we include a dummy variable for EU membership. If the country concerned was an EU member in the deadline year of the protocol concerned, this dummy scores 1. Similarly, if the country concerned was not an EU member in that year, the dummy scores 0.

In the period our data set covers, many Eastern European countries (economies in transition) would likely find participation and target achievement in many environmental treaties easy. Because many of these countries' highly polluting companies were shut down simply because they were unprofitable, significant emissions reductions would almost certainly have occurred even in the absence of the CLRTAP protocols studied. Consistent with previous studies (e.g., Aakvik and Tjøtta, 2011), we therefore include a dummy variable that scores 1 for Eastern European countries (former communist regimes) and 0 for other CLRTAP member countries.

Economic growth might influence a country's ability and willingness to participate in and meet targets under international agreements. Therefore, we include a measure of the countries' respective GDP growth (World Bank, 2018) in the period between each protocol's adoption and its deadline year.

Finally, the presence of domestic veto players may influence both the likelihood of a country ratifying an international agreement and its ability to achieve political changes necessary to meet targets. Following Börzel et al. (2010) and Peritz (2020), we therefore include the measure proposed by Henisz (2000) as a control.

6. Methods

Our main estimation strategy is to fit a series of multivariate regression models. Specifically, we fit logistic regression models to accommodate the dichotomous operationalization of the dependent variable and linear regression models for the continuous operationalization of the dependent variable (e.g., Ward and Ahlquist, 2018). Because several emissions targets in our data set belong to the same country, we cluster standard errors on countries.

The multivariate regression models allow us to estimate the correlation between participation and target achievement, while keeping included control variables constant. Yet, a main weakness of this approach is that we cannot know exactly which variables belong in the regression models and whether both excluding confounding variables (some of which may be unobserved) and including irrelevant controls may bias our inferences. To mitigate this problem, we opt to introduce the control variables sequentially to assess how including each control affects the estimated relationship between participation and target achievement. Although we cannot rule out the possibility of important unobserved confounders, this approach allows us to assess how sensitive our results are to different decisions concerning which variables to control for.

7. Results

Table 4 displays the results from a series of logistic regressions, using the dichotomous dependent variable, and linear regressions, using the continuous dependent variable. As noted, we add the control variables sequentially to assess how their inclusion affects the estimated relationship between participation and target achievement. Table 5 summarizes our three hypotheses, whether they are supported or rejected by the analysis, and the evidence in support of these conclusions.

Table 4. Logistic and linear regression coefficients (standard errors).

	Logistic regressions: Dichotomous DV								**Linear regressions: Continuous DV**							
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**	**(10)**	**(11)**	**(12)**	**(13)**	**(14)**	**(15)**	**(16)**
Participation	0.17	0.42	1.13**	1.02**	0.99**	0.89	0.94*	1.74	0.06	0.12***	0.16***	0.14***	0.14***	0.12**	0.12**	0.27
	(0.53)	(0.47)	(0.44)	(0.45)	(0.45)	(0.56)	(0.55)	(1.62)	(0.08)	(0.04)	(0.04)	(0.04)	(0.04)	(0.05)	(0.05)	(0.2
Ambition		-1.74***	-1.39***	-1.40***	-1.51**	-1.30***	-1.30***	-0.89		-0.39***	-0.35**	-0.34***	-0.34**	-0.33**	-0.33**	-0.2
		(0.62)	(0.54)	(0.52)	(0.60)	(0.49)	(0.50)	(0.77)		(0.12)	(0.13)	(0.13)	(0.13)	(0.15)	(0.15)	(0.1
Participation*Ambition								-0.60								-0.1
								(0.97)								(0.2
Govt. Effectiveness			-1.65***	-1.34**	-1.27**	-1.60**	-1.55**	-1.53**			-0.07**	-0.02	-0.02	-0.05	-0.06	-0.0
			(0.43)	(0.59)	(0.59)	(0.64)	(0.69)	(0.66)			(0.03)	(0.05)	(0.05)	(0.05)	(0.05)	(0.0
Eastern Europe				0.70	0.90	-0.18	-0.20	-0.04				0.10	0.10	0.08	0.07	0.06
				(0.87)	(0.91)	(0.90)	(0.90)	(0.94)				(0.07)	(0.07)	(0.06)	(0.06)	(0.0
EU member					0.56	0.03	0.02	0.07					-0.02	-0.05	-0.06	-0.0
					(0.43)	(0.41)	(0.42)	(0.41)					(0.04)	(0.05)	(0.05)	(0.0
GDP growth						2.20	2.29	2.01						-0.17	-0.17	-0.1
						(1.43)	(1.41)	(1.70)						(0.13)	(0.14)	(0.1
Veto players							1.24	01.07							-0.06	-0.0
							(2.37)	(2.37)							(0.13)	(0.1
Intercept	1.57***	3.58***	4.95***	4.48***	4.10***	4.42***	4.01***	3.48**	0.23***	0.63***	0.63***	0.55***	0.56***	0.69***	0.71***	0.63
	(0.46)	(0.88)	(0.96)	(1.11)	(1.10)	(1.05)	(1.45)	(1.52)	(0.07)	(0.13)	(0.12)	(0.14)	(0.13)	(0.18)	(0.16)	(0.1
AIC	175.68	155.40	140.92	142.45	143.47	136.39	138.25	139.83								

	Logistic regressions: Dichotomous DV								Linear regressions: Continuous DV							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
Log Likelihood	-85.84	-74.70	-66.46	-66.22	-65.74	-61.19	-61.13	-60.92								
Num. obs.	198	198	198	198	198	183	183	183	198	198	198	198	198	183	183	183
R2									0.00	0.28	0.30	0.30	0.30	0.30	0.30	0.31

***p<0.01; **p<0.05; *p<0.1. Standard errors clustered on countries.

Table 5. Hypotheses, conclusions, and empirical evidence.

Hypothesis	Conclusion	Evidence
H1: Participating countries are more likely to achieve predetermined emission targets than nonparticipating countries are.	Conditionally supported	There is a positive relationship between participation and target achievement, but only when controlling for possible confounders (Models 3-7 and 10-15).
H2: The positive effect of participation on target achievement persists even when controlling for the targets' ambition levels and other confounding variables.	Supported	There is a positive relationship between participation and target achievement also when controlling for ambition level (Models 3-7 and 10-15).
H3: The positive effect of participation on target achievement is weaker, the more ambitious the targets for emissions reductions.	Rejected	There is no significant interaction between participation and ambition level (Models 8 and 16).

Models 1 and 9 show that while the coefficients for participation display the expected positive sign, there is no statistically significant bivariate relationship between participation and target achievement for either the dichotomous or the continuous dependent variables. When using the dichotomous dependent variable, this null finding also holds when controlling for countries' ambition levels (model 2). On one hand, this nonsignificant finding is puzzling considering that the enforcement and management schools alike expect participation to correlate with target achievement. On the other hand, target achievement is obviously influenced by various factors, some of which correlate highly with participation decisions. As we sequentially add such controls in the subsequent models, we find evidence that participation is indeed significantly and positively associated with target achievement. When using the continuous dependent variable, we find a positive and statistically significant relationship between participation and target achievement also when only controlling for ambition level (model 10).

Models 3 and 11, which control for both ambition level and government capacity, suggest a relatively strong and statistically significant relationship between participation and both our dichotomous and continuous dependent variable. This relationship holds across the subsequent models, which add controls for Eastern European countries (models 4 and 12), EU members (models 5 and 13), GDP growth (models 6 and 14), and veto players (models 7 and 8). Overall, these results thus provide support for both H1 and H2: a positive relationship exists between participation and target achievement, and this relationship is robust to controlling for ambition level and other confounding variables. Support for H2 is consistent with managerial accounts, but not with the enforcement school's expectations.

To illustrate the substantive interpretation of our findings, Fig. 1 displays predicted probabilities of target achievement conditional on participation based on model 7. Other variables are kept at their mean (continuous variables) or mode (categorical variables) levels. The error bars indicate 95% confidence intervals. While the predicted probability of target achievement is quite high even for nonparticipants (0.88), it is even higher for participants (0.95). Thus, participants are considerably more likely to meet their targets than nonparticipants are. Both estimates are associated with considerable uncertainty and the 95% confidence interval for the difference (barely) crosses zero.[14] Yet, this comparison provides evidence of a substantively important relationship between participation and target achievement, even when controlling for ambition and other confounding variables.

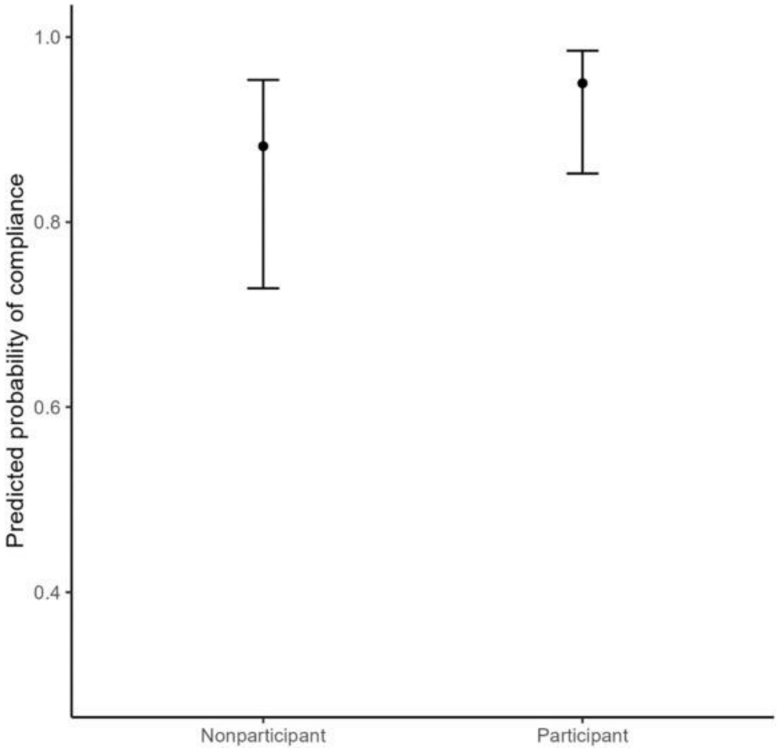

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Fig. 1. Predicted probabilities of target achievement conditional on participation based on model 7. Other variables are set at their mean (continuous variables) or mode (categorical variables). Error bars indicate 95% confidence intervals.

Concerning the general relationship between participation and target achievement, our results suggest that behavioral changes have occurred in CLRTAP member countries. These changes may help explain at least part of the reductions in air pollution observed in Europe in recent decades. Unfortunately, however, it seems that this development has been accompanied by extensive leakage, that is, a corresponding increase in emissions elsewhere (Kanemoto et al., 2014).

Models 8 and 16 include the interaction term between participation and ambition needed to test hypothesis 3. The interaction term has the expected negative sign but fails to reach statistical significance by any conventional level. Fig. 2 displays the estimated marginal effects of participation at different ambition levels, based on models 8 (left panel) and 16 (right panel). The figure shows that, in line with hypothesis 3, the relationship between participation and target achievement is lower for more ambitious targets, but the difference is not statistically significant. It should be noted that due to the relatively low number of observations in our dataset, we have limited statistical power to detect such an interaction effect (e.g., Gelman et al., 2020: 301-303). Thus, although we cannot refute the null hypothesis of no interaction effect, nor can we conclude that we have found evidence of the *absence* of an interaction.

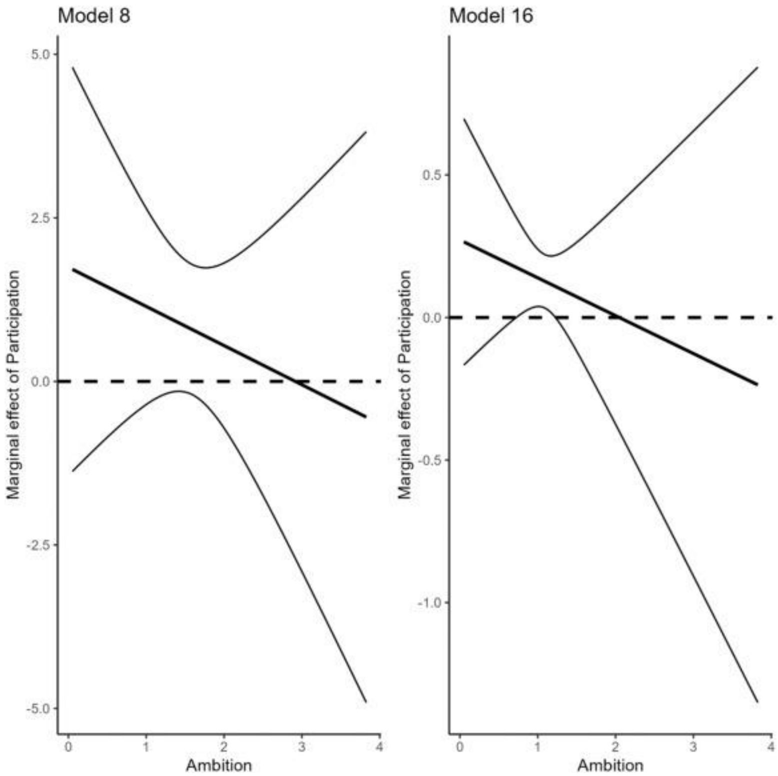

Fig. 2. Marginal effect of participation on target achievement for different ambition levels along with the 95% confidence intervals based on Models 8 (right panel) and 16 (left panel) in Table 4.

In the supplementary materials, we report the results of two robustness checks. [15] First, to account for unobserved differences at country and protocol levels, we estimated the models with protocol- and country-fixed effects. The positive relationship between participation and target achievement is robust to including protocol-fixed effects (models 17 and 18). For the continuous DV measure, results are also robust to adding country-fixed effects (model 19), although in this model the relationship is (marginally) insignificant at the 0.05 level (*p=0.057)*. This loss of precision is unsurprising given the high number of parameters estimated when including country-fixed effects. Moreover (and related), insufficient country-level variation exists to include country-fixed effects when considering the dichotomous outcome measure.

Second, we re-estimated our models after first pre-processing the data using nearest neighbor-matching on the mahalanobis distance (see Rubin, 1980 and the discussion in our Supplementary Materials). Compared to adjusting for confounders using multivariate regression, matching reduces the dependence of the results on hard-to-justify assumptions concerning the functional forms of the relationships between included covariates and on "implausible counterfactuals" (Ho et al., 2007). As shown in Section A.2 of the Supplementary Materials, our results are robust to pre-processing the data using matching.

8. Conclusions

Both the enforcement school and the management school expect that countries participating in international agreements should be more likely than nonparticipating countries to meet predetermined targets. However, while the management school ascribes this expected association to the treaty's constraining effect, the enforcement school ascribes it to a screening effect. If the latter conjecture is correct (and assuming selection only on observables), the association between participation and target achievement should largely disappear when controlling for the targets' ambition levels and other confounding factors.

Using a novel data set comprising three CLRTAP protocols, we test this hypothesis using a series of logistic and OLS regression models. We find a consistently positive and statistically significant effect of participation on target achievement even when controlling for ambition level and several other confounding variables. This result is easier to align with the expectations of the management school than with those of the enforcement school.

Our results are, however, not entirely one-sided. First, the results are less conclusive concerning hypothesis 3 than regarding hypotheses 1 and 2. On one hand, the estimated interaction effect between participation and ambition level is negative, which seems to align with the expectations of the enforcement school. On the other hand, this interaction fails to reach conventional levels of statistical significance; thus, we cannot reject the null hypothesis of no interaction effect. Second and as noted, the enforcement school's expectations rely heavily on cost considerations. The finding of a consistently negative and mostly significant effect of ambition indicates that cost considerations constitute an important driver of target achievement, although we find little indication that such considerations affect participation. Finally, contrary to the expectations of the management school, protocols included in our data set display numerous examples of formal noncompliance by participants, and we find no evidence that state capacity is a main driver of it.

Of course, we cannot exclude the possibility that controlling for even more confounding variables (or using different operationalizations) would cause the positive effect of participation on target achievement to vanish. However, further such efforts must be left for future research.

We end by highlighting a few issues regarding the possibility of generalizing our findings to other treaties – the first is methodological, the others are substantive. First, scholars aiming to use our methodological approach on other treaties might face considerable challenges. The reason is simply that treaties like our three CLRTAP protocols are rare, in at least two respects. Not only do they include targets both for participants and for relevant nonparticipants (i.e., CLRTAP countries that did not ratify the protocol concerned); they also include significant variation regarding all three key variables (i.e., participation, target depth, and the extent to which targets were met by the deadline). Not many other agreements share all these features. For example, although the Paris Agreement apparently displays considerable variation concerning whether countries are on track to meet their targets, it differs from our three protocols in other important ways. Paris quickly achieved nearly full participation, and the few remaining nonparticipants do not have targets comparable to those of participants. And even for participants, substantial barriers exist for comparing ambitiousness (Young 2016). Paris would therefore offer a more challenging ground for testing the hypothesis considered here than our three protocols do. Indeed, scholars embarking on such an undertaking would probably need to use a different approach than ours.

Second, although screening does not seem to occur in the CLRTAP protocols studied here, it might still be important for climate agreements and other treaties likely to entail very high costs for participants. Indeed, the US abandoning of the Kyoto Protocol was at least partly motivated by cost considerations, as shown by the Byrd-Hagel resolution passed by the US Senate in 1997[16] and by President George W. Bush's repudiation of the treaty in 2001.[17] Moreover, fear of screening effects may also help explain the decision to let participants determine their own commitments under the Paris Agreement.

Third, some of the most important recent environmental agreements – such as the Paris Agreement and the Kunming–Montreal Pact – differ from our three CLRTAP protocols by invoking a bottom-up approach based on pledge and review. It remains to be seen what this approach will entail for the relationships between participation, ambition, and target achievement.

Fourth, other recent agreements are more like our three CLRTAP protocols. For example, the Kigali Amendment to the Montreal Protocol imposes timetables and emissions reduction targets, the implementation of which will likely entail middle-range costs. Thus, it would be unsurprising if studies of Kigali were to deliver findings resembling ours. It also seems that Kigali is one of few cases where our methodological approach could be applicable – at least if the current situation, with quite a few Montreal parties not having ratified Kigali, should persist.[18]

Finally, it is notable that the bottom-up pledge-and-review designs of the Paris Agreement and the Kunming–Montreal Pact rely almost entirely on advice offered by the management school. For example, both treaties depend heavily on norms building and provide (at best) few international incentives. Moreover, the Kunming-Montreal Pact is not legally binding, while the Paris Agreement explicitly rules out enforcement. Thus, should our results prove generalizable even to such high-cost treaties, they would seem to constitute good news for these treaties' fulfillment.

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CRediT authorship contribution statement

Andreas Kokkvoll Tveit: provided the original idea to the paper and collected the data, Data curation, The authors contributed equally to writing and revising the paper. **Jon Hovi:** contributed the theoretical parts of the paper and drafted the hypotheses, Writing – original draft, The authors contributed equally to writing and revising the paper. **Øyvind Stiansen:** analyzed the data and provided the data, Visualization, Formal analysis, Data curation, The authors contributed equally to writing and revising the paper.

Declaration of competing interest

The authors declare no conflict of interest.

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Appendix A. Supplementary data

The following is the supplementary data to this article:

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Multimedia component 1.

Recommended articles

Data availability

Replication data and code are available from https://dataverse.harvard.edu/dataset.xhtml?persistentId=doi:10.7910/DVN/S8PITA.

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1 By relevant nonparties, we mean CLRTAP members choosing not to ratify the protocol concerned.

2 Isaksen (2020) constitutes an exception.

3 Gilligan (2004) provides another conditional argument, contending that deep commitments may or may not deter participation, depending on other aspects of the treaty's design. For example, negotiators may include opt-in or opt-out clauses to make participation acceptable to more countries.

4 Unlike some other international environmental agreements, including the Montreal Protocol and the Paris Agreement, CLRTAP protocols do not offer financial support for countries to implement their commitments.

5 The reason for the term “enforcement school” is that this school's proponents consider it unlikely that high compliance rates can also be achieved for treaties with deep commitments – unless those treaties include (severe and credible) enforcement measures.

6 For countries, violating treaties they have ratified constitutes a breach of international law, whereas declining to ratify does not.

7 Per the enforcement school, any cooperation going beyond BAU would require strict enforcement. For various reasons, strict treaty enforcement is often politically infeasible. The CLRTAP protocols considered here do not include enforcement systems.

8 Institutionally, the CLRTAP is located under the United Nations Economic Commission for Europe.

9 Prior to its establishment by the 1993 Maastricht Treaty, the EU was known as the European Economic Community (EEC). However, we use its current name, the European Union (EU).

10 Although 2000 is considered its primary deadline year, the Oslo Protocol also specified SO_2 emissions targets for 2005 and 2010. Thus, the adoption of the 1999 Gothenburg Protocol implied that several countries had SO_2 emissions targets for 2010 in two protocols. To avoid counting countries' compliance (or noncompliance) with 2010 SO_2 targets twice, we exclude Oslo's 2010 emissions targets from our data set. However, because Oslo is the only CLRTAP protocol specifying SO_2 targets for 2005, we include Oslo's 2005 targets in the data set.

11 In total, eight CLRTAP protocols exist. Three do not include national emissions targets. Two include percentage-based emissions-reduction requirements yet let each participating state determine its own baseline year, thereby preventing us from calculating comparable emissions targets for nonparticipants.

12 All three protocols include a minimum participation clause stating that they enter into force when sixteen countries have ratified, thereby changing the incentive for ratification. However, this change should not have any major consequences for our analyses: Although affecting participation decisions, these clauses cause omitted-variable bias only if they also affect target achievement through other variables than participation.

13 WGI scores are based on surveyed views of experts, citizens, and enterprise respondents.

14 Specifically, the 95% confidence interval for the difference between the two predictions ranges from –0.007 to 0.18. Note that the overlap between the confidence intervals for the two point estimates does not indicate that the *difference* between these two estimates is not statistically significant. Such an assessment requires constructing a confidence interval (or test statistic) for the *difference* rather than for the point estimates (e.g., Austin and Hux, 2002).

15 Regrettably, with our data it proved difficult to get Von Stein's (2005) selection model to converge. Likely causes include relatively few observations and (partly) the lack of a strong instrument to ease identification of the model. We similarly attempted estimating a two-stage model with the number of IGOs a country is member of as an instrument for treaty participation – as Conrad and Ritter proposed (2013) – but the first-stage results showed that this potential instrument is too weak to be considered relevant.

16 S.Res.98 - 105th Congress (1997-1998): A resolution expressing the sense of the Senate regarding the conditions for the United States becoming a signatory to any international agreement on greenhouse gas emissions under the United Nations Framework Convention on Climate Change. | Congress.gov | Library of Congress.

17 https://ozone.unep.org/all-ratifications ↗.

18 After listwise deletion of observations with missing values, 85 participants and 36 nonparticipants were left.