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Impacts of Trade and the Environment on Clustered Multilateral Environmental Agreements

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1. INTRODUCTION

> The interconnectedness of the global environment is beyond dispute. […] coordinated international action is essential to protecting Earth's climate, preserving its biodiversity, and managing its marine and other common resources. (World Resources Institute, International Environmental Governance, 2003, p. 137)

OPENNESS to the international economy and the environment intersects in many different ways. While one part of the literature argues that a more stringent environmental policy harms goods trade (see, among others, d'Arge, 1974; Pethic, 1976; Siebert 1977; McGuire, 1982; OECD, 1985; Markusen, 1999; Ulph, 1999; Millimet and List, 2004) and foreign direct investment (see Walter, 1982; Pearson, 1985, 1987; Leonard, 1988; Taylor, 2005), the other part of the literature provides evidence of a limited detrimental impact of environmental policy for trade (see Tobey, 1990; Porter, 1991; van Beers and van den Bergh, 1997, 2000; Berman and Bui, 2001; Alpay et al., 2002; Lanoie et al., 2008) or foreign direct investment (see Porter and van der Linde, 1995; Bjørn et al., 1997; Xu and Song, 2000). Clearly, in the absence of evidence for strong negative economic effects of a more stringent environmental policy, one would even less hesitantly argue in favour of its inception. Multilateral environmental agreements (MEAs) are one widely adopted measure to introduce and coordinate stringent environmental policies across countries. Recent work at the interface between macroeconomics and international economics indicated that cooperation in environmental agreements may induce positive effects on international economic issues beyond the environment (see Rose and Spiegel, 2009) and cooperation in trade and investment agreements makes cooperation in environmental agreements more likely (see Egger et al., 2011).

While earlier academic work provided insights into the dynamic, economic and political determinants of participation in environmental agreements at large from a theoretical as well as an empirical perspective (see Chandler and Tulkens, 1992; Hoel, 1992, 2005; Barrett, 1994; Hoel and Schneider, 1997; Tol, 1997, 2001; Carraro, 1998; Finus and Rundshagen, 1998a, 1998b; Neumayer, 2002; Barrett and Stavins, 2003; Beron et al., 2003; Carraro et al., 2003; Eyckmans and Tulkens, 2003; Lange and Vogt, 2003; Mitchell, 2003; Murdoch et al., 2003; Buchholz et al., 2005; Carraro et al., 2006; Weikard et al., 2006; Egger et al., 2011), little is known about the role

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of these determinants for MEAs of specific type and about spillovers in the MEA participation across issues. Even at the level of all MEAs, Mitchell (2003, p. 431) emphasises that 'the empirical basis for claims regarding the number of such agreements and their characteristics remains weak'. Close to nothing is known about the determinants of the numbers of such agreements at the level of different environmental issues.

This paper aims at filling this gap by proposing an empirical model of the number of specific MEAs regarding environmental issues, which involves economic, political and environmental determinants. For this purpose, we classify MEAs into clusters covering different environmental issues. Following the classification of MEAs of the United Nations Environment Programme (2001; UNEP MEA Clusters), we discern five clusters: biodiversity, atmosphere, land, chemicals and hazardous wastes, and seas. Besides economic and political fundamentals of MEA ratification by cluster, we consider spillover effects in the MEA participation in some clusters on the participation in other clusters. This analysis reveals that MEA participation is not contagious across all clusters. For example, land-related MEAs only influence participation in biodiversity-specific MEAs, but not other ones. By way of contrast, MEAs classified as chemicals and hazardous wastes provide significant stimuli on the participation in MEAs on other issues.

The remainder of the paper is organised as follows. Section 2 describes MEA ratification across clusters and countries by way of maps. This provides first insights concerning the differences and similarities between clusters. Section 3 outlines the econometric model. We distinguish three key types of determinants of MEAs in Section 4, define the corresponding variables and report on the data sources. Section 5 summarises the parameter estimates and marginal effects based on dynamic linear feedback models for counts of MEAs in a cluster countries participate in. The last section offers some concluding remarks.

2. THE GEOGRAPHY OF MEA PARTICIPATION ACROSS CLUSTERS

We illustrate the geography of MEA ratifications across 199 countries and MEA clusters in the year 2006 by means of maps. For this, we compile data on MEAs from two sources: the Socioeconomic Data and Applications Center (SEDAC) Database of the Center for International Earth Science Information Network (CIESIN) (2006) and data provided by courtesy of Mitchell (2007). The latter database enabled to broaden the CIESIN SEDAC data set and extend it until the year 2006. For illustration, we associate specific grey shades with the 0–20, 20–40, 40–60, 60–80 and 80–100 quantiles of MEA numbers, with darker shades identifying relatively fewer and lighter shades identifying relatively more MEAs concluded in a country and cluster. The darkest two shades of grey indicate countries with fewer MEAs concluded in a cluster than the centre quintile of the distribution. Ordinary grey identifies countries with as many MEAs as in the centre quintile of the distribution. The lighter two shades of grey identify countries more MEAs ratified than the median country. Subsequently, we provide individual maps of MEAs in 2006 for the clusters biodiversity, atmosphere, land, chemicals and hazardous wastes, and seas.

From the colour scales and associated MEA numbers in the lower left corner of each of the five maps, it is evident that the MEA clusters differ with respect to the number of MEAs across the five quintiles. Only up to 21 MEAs in the cluster land were ratified by an economy, while up to 94 MEAs were signed by a country in the cluster seas. In the cluster Biodiversity, both France and Sweden ratified the largest number of MEAs until 2006, whereas Germany and Luxembourg were the ones with the highest number of MEAs in the atmosphere cluster. Germany also ratified the largest number of MEAs in the clusters *Land* and chemicals and hazardous wastes. France participated in more MEAs of the seas type than

any other economy in 2006. Besides European countries, the US, Canada, Japan, Korea, India, Australia, New Zealand, Russia, Egypt, Argentina, Chile, Ecuador and Peru were among the countries that had an above-average number of MEAs ratified (light grey or very light grey) across all types of MEA clusters (Figures 1–5).

3. ECONOMETRIC MODEL

While Figures 1–5 portrayed the number of MEAs per cluster and country as of 2006, it is important to note that the time process of a country's MEA ratification of any type displays

FIGURE 1
The Number of Multilateral Environmental Agreements in 2006 – Cluster: Biodiversity

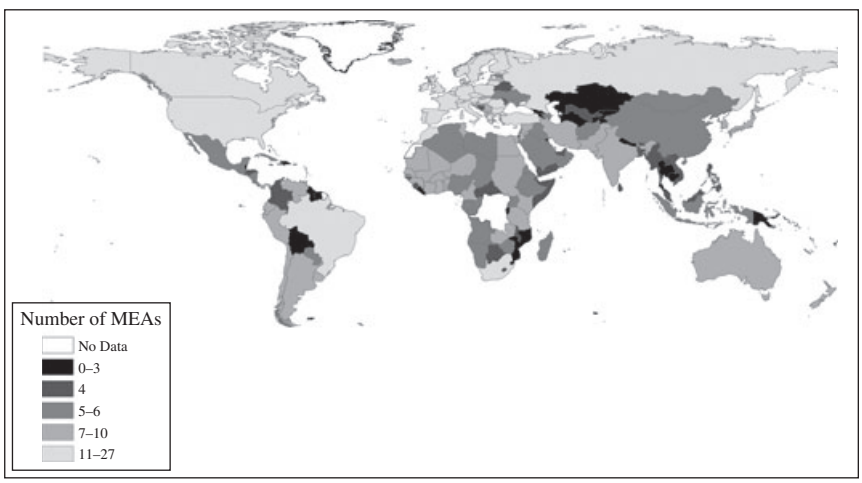


FIGURE 2
The Number of Multilateral Environmental Agreements in 2006 – Cluster: Atmosphere

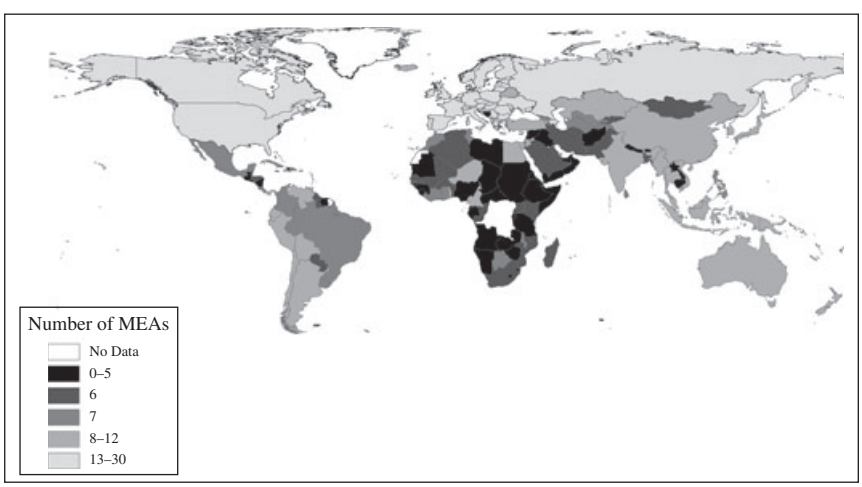


FIGURE 3
The Number of Multilateral Environmental Agreements in 2006 – Cluster: Land

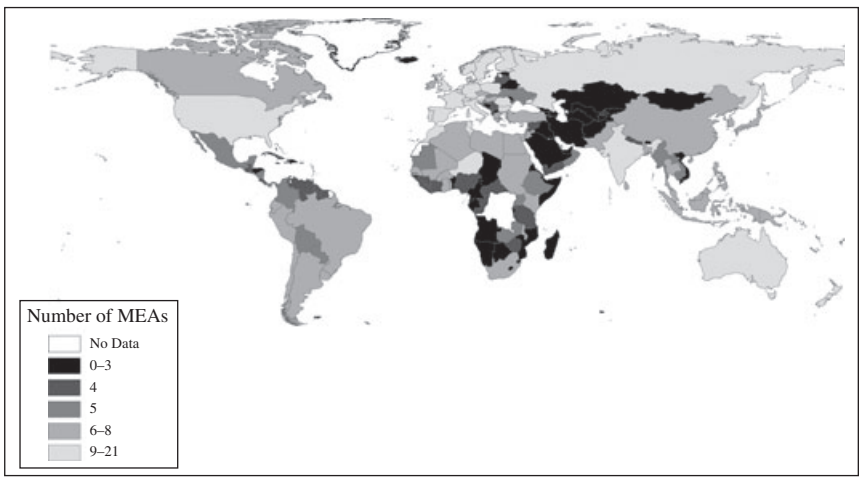
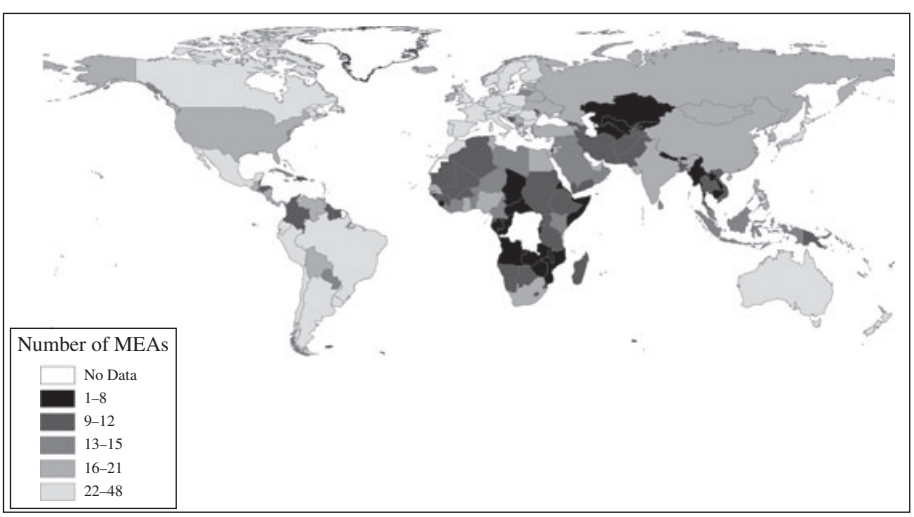
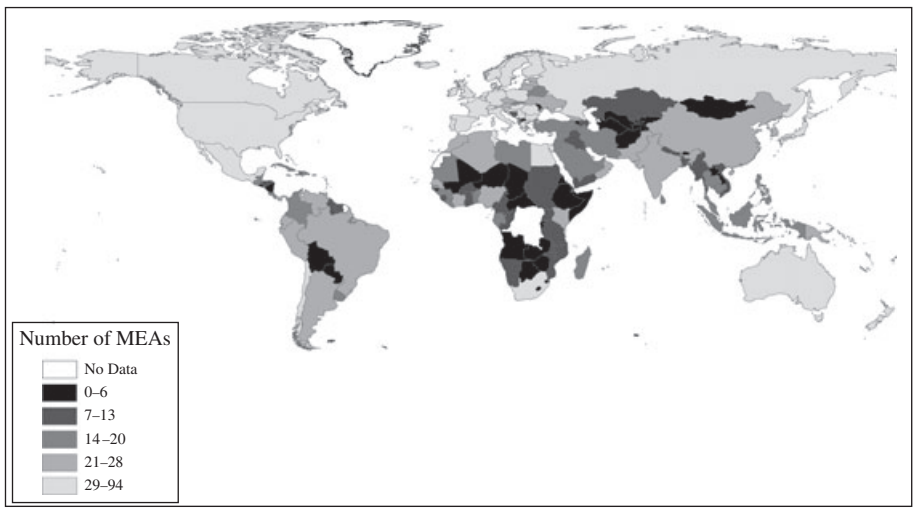


FIGURE 4
The Number of Multilateral Environmental Agreements in 2006 – Cluster: Chemicals and Hazardous Wastes



strong persistence. For every country and year and unconditional on any fundamentals, the number of MEAs ratified of a specific type follows an autoregressive process which can be represented by an AR(1) process. In any case, the autoregressive process is as strong that we would not expect to be able to capture dynamics fully by the inclusion of explanatory variables. Accordingly, a country's MEA history should be used for explaining the current number of MEAs of that country, and it appears sufficient to include the first-order time lag of a country's number of MEAs for that purpose. Of course, lagged dependent variables are not exogenous in panel data models of limited time span. We follow Blundell et al. (2002) to

FIGURE 5
The Number of Multilateral Environmental Agreements in 2006 – Cluster: Seas



model the dynamics of the number of MEAs a country ratifies as a dynamic linear feedback model (LFM) for count data. In such a model, the conditional mean of a dependent count variable is assumed to be linear in the history of the process (see Chamberlain, 1993; Windmeijer and Santos Silva, 1997; Windmeijer, 2000, 2005, 2008; Hall, 2005).

The conditional mean in the standard LFM is defined as

$$\begin{aligned} E(y_{it}|y_{it-1}, x_{it}, \eta_i) &= \gamma y_{it-1} + \exp(x'_{it}\beta + \eta_i) \\ &= \gamma y_{it-1} + \mu_{it}\upsilon_i, \end{aligned} \tag{1}$$

where y_{it} denotes the number of MEAs country i, $i = 1, ..., N$, has ratified in year t, $t = 1, \ldots, T$. x_{it} represents a vector of K explanatory variables, and $\upsilon_i \equiv \exp(\eta_i)$ is a scaling factor for the i-specific mean and $\mu_{it} = \exp(x'_{it}\beta)$. The parameters γ and β are to be estimated. According to Windmeijer (2008), the LFM can also be motivated as an entry–exit process with the probability of exit equal to $(1-\gamma)$. Moreover, the mean value for y_{it} is bounded from below by γy_{it-1} as $\mu_{it}\upsilon_i$ is non-negative.

As the number of MEAs is predetermined, that is, determined prior to the current period,

$$\begin{aligned} E(u_{it+j}y_{it}) &= 0, \quad j \geq 0, \\ E(u_{it-s}y_{it}) &\neq 0, \quad s \geq 1, \end{aligned}$$

the within-group mean scaling estimator will be inconsistent in short panels. But with the Wooldridge's quasi-differencing transformation (Wooldridge, 1997),

$$q_{it} = \frac{y_{it} - \sum_{j=1}^{p} \gamma_j y_{it-j}}{\mu_{it}} - \frac{y_{it-1} - \sum_{j=1}^{p} \gamma_j y_{it-1-j}}{\mu_{it-1}},$$

the moment condition $E(q_{it}|y_{it-2}, x_{it-1}) = 0$ holds for predetermined variables. Furthermore, this transformation can handle endogenous x_{it} with $E(q_{it}|y_{it-2}, x_{it-2}) = 0$ as a valid moment condition. In either case, the generalised method of moments (GMM) estimator is defined as

$$\hat{\theta} = \arg\min \left(\frac{1}{N} \sum_{i=1}^{N} q_i(\theta)' Z_i \right) W_N^{-1} \left(\frac{1}{N} \sum_{i=1}^{N} Z_i' q_i(\theta) \right),$$

where $\theta = (\gamma_1, \ldots, \gamma_p, \beta')'$, q_i is the $T-p-1$ vector of residuals q_{it}, Z_i is the matrix of instruments, and W_N is a weight matrix, which is optimally chosen as follows:

$$W_N(\hat{\theta}) = \frac{1}{N} \sum_{i=1}^{N} Z_i' q_i(\hat{\theta}) q_i(\hat{\theta})' Z_i.$$

Here, $q_i(\hat{\theta})$ stems from an initial consistent estimate $\hat{\theta}$. Otherwise, for example, for the one-step GMM estimator, a proper initial weight matrix is

$$W_N = \frac{1}{N} \sum_{i=1}^{N} Z_i' Z_i.$$

By definition of $\hat{\theta}$, the GMM estimator is asymptotically normally distributed and its asymptotic variance can be computed as

$$\hat{\text{var}}(\hat{\theta}) = \frac{1}{N} (C(\hat{\theta})' W_N^{-1} C(\hat{\theta}))^{-1} C(\hat{\theta})' W_N^{-1} W_N(\hat{\theta}) W_N^{-1} C(\hat{\theta}) (C(\hat{\theta})' W_N^{-1} C(\hat{\theta}))^{-1},$$

where

$$C(\hat{\theta}) = \frac{1}{N} \sum_{i=1}^{N} \left. \frac{\partial Z_i' q_i(\theta)}{\partial \theta} \right|_{\hat{\theta}}.$$

In a second step, to capture spillover effects in the ratification across different MEA clusters, we extend the LFM using superscript c to refer to clusters.

$$\begin{aligned} E(y_{it}^c | y_{it-1}^c, x_{it}, \eta_i) &= \gamma y_{it-1}^c + \exp(\tau y_{it-1}^{C \neq c} + x_{it}' \beta + \eta_i) \\ &= \gamma y_{it-1}^c + \mu_{it} \upsilon_i, \end{aligned} \tag{2}$$

with $\exp\left(\tau y_{it-1}^{C \neq c} + x_{it}' \beta\right)$ now. Here, the parameter τ measures the extent of spillovers of previously ratified MEAs in one or all other clusters (referred to by $C \neq c$) on the ratification of MEAs in cluster c conditional on the fundamentals in x_{it}.

We compare different strategies to estimate the parameters γ, τ and β. It turns out that, in the context of MEAs, the one-step estimator using Wooldridge's moment conditions is preferred over other GMM estimators. According to Windmeijer (2002), we found that the efficient two-step GMM estimator, which uses the estimates from the one-step estimator for the moments weighting matrix and the continuously updated GMM estimator that directly accounts for the dependence of the moments weighting matrix on the parameters in the optimisation (Hansen et al., 1996), is severely downward biased because of the relatively small number of countries N in our sample. Using a finite sample correction with block-bootstrapping in order to solve for the small sample bias could only reproduce the results from the one-step estimator (cf. Egger et al., 2011).

4. DETERMINANTS OF MEA RATIFICATION

Theoretical work on environmental agreements typically uses stylised emission abatement costs and benefits or climate change damage costs and side payments when determining partic-

ipation in agreements. Other work applies a payoff share of the public good dubbed 'clean environment' (see Chandler and Tulkens, 1992; Hoel, 1992, 2005; Barrett, 1994, 1997, 2001; Hoel and Schneider, 1997; Tol, 1997, 2001; Carraro, 1998; Finus and Rundshagen, 1998a, 1998b; Frankel and Rose, 2002; Swanson and Mason, 2002; Barrett and Stavins, 2003; Carraro et al., 2003, 2006; Eyckmans and Tulkens, 2003; Lange and Vogt, 2003; Caparrós et al., 2004; Buchholz et al., 2005; Naghavi, 2005; Weikard et al., 2006). Since direct measures of the costs of pollution, of side payments and of payoff shares are not available, we follow the empirical literature to propose a reduced form of the determinants of environmental agreement participation as a function of observable economic, political and environmental fundamental variables. This specification is supposed to capture direct effects of these fundamentals on MEA ratification as well as indirect ones of the unmeasured costs of pollution, side payments and payoff shares. Table 1 lists the economic, political and environmental fundamental variables that are employed in our specification of the ratification of the number of MEAs. In what follows, we focus on a balanced panel data set where the dependent and the explanatory variables are available for 110 countries in all covered 47 years so that we are left with 5,170 observations.

In the horizontal dimension, the table provides the acronym of the respective variable, the average value, the standard deviation and the minimum and maximum of that variable. In the

TABLE 1
Statistics of Balanced Data

Variable	*Mean*	*SD*	*Min*	*Max*
Left-hand side (dependent) variables				
Number of MEAs	32.2445	34.4753	0	212
CLUSTER BIODIVERSITY	4.0178	4.4381	0	27
CLUSTER ATMOSPHERE	3.8143	5.4397	0	30
CLUSTER LAND	2.8845	2.7611	0	21
CLUSTER CHEMICALS	8.5178	8.5266	0	48
CLUSTER SEAS	12.9727	15.3181	0	94
Right-hand side spillover variables				
CLUSTER $\neq$ BIODIVERSITY	28.2267	30.3859	0	185
CLUSTER $\neq$ ATMOSPHERE	28.4302	29.6939	0	186
CLUSTER $\neq$ LAND	29.3226	32.1034	0	195
CLUSTER $\neq$ CHEMICALS	23.7267	26.3782	0	164
CLUSTER $\neq$ SEAS	19.2718	19.9618	0	123
Economic determinants of MEAs				
LGDP	23.5477	2.1554	17.8967	30.0656
LPOP	9.3292	1.4516	6.2086	14.0895
TRADE LIBERAL	1.4270	1.8332	−4.1154	5.2542
INVEST LIBERAL	9.6680	18.5627	0	131
LDC	0.1818	0.3857	0	1
Political determinants of MEAs				
PFI	4.9579	1.9583	1	9.6
Environmental determinants of MEAs				
PLANT SPECIES	52.8575	111.4035	0	683
CO_2 EMISSIONS	3.6872	4.4801	−0.0197	27.7664
AGRRAW	9.4035	13.1677	0	88.7417

Note:
(i) The sample is based on 110 countries, 47 years and 5,170 observations.

vertical dimension, we report statistics on the number of all MEAs at the top, on the number of MEAs by cluster in the second bloc at the top, on the number of MEAs in all but one cluster in the third bloc and on economic, political and environmental determinants in the fourth to sixth bloc, respectively.

The meaning of the acronyms in Table 1 is as follows. All variables under the heading 'Left-hand side (dependent) variables' measure numbers of MEAs across all or within a specific cluster as indicated. All variables under the heading 'Right-hand side spillover variables' measure numbers of MEAs in all clusters except the indicated one. The heading 'Economic determinants of MEAs' subsumes five covariates: LGDP measures a country's log real GDP in a year; LPOP measures a country's log population in a year; TRADE LIBERAL is a multilateral trade liberalisation measure for a country in a year in logs; INVEST LIBERAL is a multilateral investment liberalisation measure for a country in a year in logs; and LDC is a binary indicator variable which is unity for less developed countries and zero else. The only entry under the heading 'Political determinants of MEAs' is PFI that measures a country's political freedom index in a year. The heading 'Environmental determinants of MEAs' covers three covariates: PLANT SPECIES measures the number of endangered species in a country and year; CO_2 EMISSIONS measures a country's CO_2 emissions in kilo-tons (kt) in a year; and AGRRAW reflects agricultural raw materials exports in per cent of merchandise exports. The subsequent sections report some more detail on these variables and their hypothesised effects on the number of MEAs ratified per cluster.

a. Economic Determinants

The variables LGDP and LPOP are supposed to capture a country's economic size. The source data for these variables are taken from Maddison's (2003) historical time-series and extrapolated for more recent years by using indices of real GDP growth in US dollars and of population from the World Bank's World Development Indicators 2008 (World Bank, 2008), respectively.

TRADE LIBERAL measures the importance of bilateral and multilateral trade costs, among others, through preferential trade agreement (PTA) membership, to account for direct and indirect consequences of trade costs. In a nutshell, TRADE LIBERAL reflects the inverse of a country's multilateral trade costs in a year.[1] Similar to LGDP and LPOP, we use the log of inverted trade costs for TRADE LIBERAL. INVEST LIBERAL is a measure of a country's investment liberalisation that simply reflects the number of bilateral investment treaties (BITs) of a country.[2] Since TRADE LIBERAL or INVEST LIBERAL may be endogenous, we apply Wooldridge's quasi-differencing transformation – as stated above – which can deal with potentially endogenous regressors (see Wooldridge, 1997; Windmeijer, 2008).

Finally, LDC is included to allow for a link between the number of MEAs ratified and the development status of a country. This variable is constructed from data of the United Nations Office of the High Representative for the Least Developed Countries, Landlocked Developing Countries and Small Island Developing States (UN-OHRLLS).

[1] For more details on TRADE LIBERAL, see Anderson and van Wincoop (2003).
[2] We use BITs from the United Nations Conference of Trade and Development Treaty Database (UNCTAD, 2007).

TABLE 2
Parameter Estimates with $E(y_{it}^{c}|y_{it-1}^{c}, x_{it}, v_i)$

	Number of MEAs	*Biodiversity (Number of MEAs)*	*Atmosphere (Number of MEAs)*	*Land (Number of MEAs)*	*Chemicals (Number of MEAs)*	*Seas (Number of MEAs)*
Lagged dependent variables						
y_{it-1}^{NBMEA}	0.1594***					
$y_{it-1}^{BIODIVERSITY}$		0.0058				
$y_{it-1}^{NBMEA \neq BIODIVERSITY}$		0.0122***				
$y_{it-1}^{ATMOSPHERE}$			0.3833***			
$y_{it-1}^{NBMEA \neq ATMOSPHERE}$			0.0115***			
y_{it-1}^{LAND}				0.0264		
$y_{it-1}^{NBMEA \neq LAND}$				0.0020***		
$y_{it-1}^{CHEMICALS}$					0.0671***	
$y_{it-1}^{NBMEA \neq CHEMICALS}$					0.0073***	
y_{it-1}^{SEAS}						0.0899***
$y_{it-1}^{NBMEA \neq SEAS}$						0.0099***
Economic determinants						
$LGDP_{it}$	0.8490***	0.5164***	0.4507***	0.1775***	0.6899***	0.5556***
$LPOP_{it}$	0.0901	0.0616	0.1053**	0.2521**	−0.0397	0.1139
TRADE $LIBERAL_{it}$	0.6701***	0.4062***	0.5504***	0.1756*	0.5507***	0.3960***
INVEST $LIBERAL_{it}$	0.0032***	−0.0011	0.0008	0.0019**	0.0006	−0.0061***
LDC_{it}	0.8518*	0.7493**	0.0600	−0.0495	0.0169	−0.0410
Political determinants						
PFI_{it}	0.0620***	0.0173	0.0325*	−0.0013	−0.0409***	0.0833***
Environmental determinants						
PLANT $SPECIES_{it}$	−0.0011***	−0.0004**	−0.0003	−0.0002	0.0002	−0.0014***
$AGRRAW_{it}$	−0.0180***	−0.0088**	−0.0079	0.0017	−0.0041	−0.0185***
CO_2 $EMISSIONS_{it}$	−0.0117	−0.0163	0.0495**	−0.0082*	−0.0298**	0.0044

Notes:
(i) *t*-Statistics in parentheses.
(ii) There are 110 countries and 5,170 observations in all six ONE-STEP regressions.
(iii) The parameters are estimated over the period 1962–2006.
(iv) Once and twice lagged levels of the dependent and the independent variables are used as instruments (i.e. values of 1960 and 61 are used as instruments for 1962).
(v) *, **, *** indicates that parameters are significant at 10%, 5% and 1%, respectively.

b. Political Determinants

The index of political freedom (PFI) is published by the Fraser Institute (Gwartney et al., 2007) and ranges from 1 to 10. The index is a compound measure of the quality of a country's legal structure, the security of property rights and the ease of access to sound money in a year. A higher index value reflects greater political freedom in a country and year.

c. Environmental Determinants

The three environmental determinants of MEA ratification are based on the following sources. PLANT SPECIES reflects the degree of habitat protection of species (the number of

TABLE 3
Parameter Estimates with $E(y_{it}^c|y_{it-1}^c, x_{it}, v_i)$;$c$ = *BIODIVERSITY*

	Biodiversity (Number of MEAs)	*Biodiversity (Number of MEAs)*	*Biodiversity (Number of MEAs)*	*Biodiversity (Number of MEAs)*	*Biodiversity (Number of MEAs)*
Lagged dependent variables					
$y_{it-1}^{BIODIVERSITY}$	0.0058	0.0138	0.0139	0.0100	0.0129
$y_{it-1}^{NBMEA \neq BIODIVERSITY}$	0.0122***				
$y_{it-1}^{ATMOSPHERE}$		0.0125**			
y_{it-1}^{LAND}			0.0355*		
$y_{it-1}^{CHEMICALS}$				0.0316***	
y_{it-1}^{SEAS}					0.0185***
Economic determinants					
$LGDP_{it}$	0.5164***	0.7391***	0.6095***	0.5637***	0.5471***
$LPOP_{it}$	0.0616	0.0414	0.0727	0.0630	0.0544
TRADE $LIBERAL_{it}$	0.4062***	0.5231***	0.5211***	0.3952***	0.4459***
INVEST $LIBERAL_{it}$	−0.0011	0.0029**	0.0048***	0.0008	0.0030**
LDC_{it}	0.7493**	0.9797**	0.9099**	0.8675**	0.7793**
Political determinants					
PFI_{it}	0.0173	0.0325***	0.0297**	0.0363***	0.0125
Environmental determinants					
PLANT $SPECIES_{it}$	−0.0004**	−0.0004**	−0.0004**	−0.0006***	−0.0002
$AGRRAW_{it}$	−0.0088**	−0.0110***	−0.0118***	−0.0099***	−0.0081**
CO_2 $EMISSIONS_{it}$	−0.0163	−0.0178	−0.0150	−0.0163	−0.0147

Notes:
(i) *t*-Statistics in parentheses.
(ii) There are 110 countries and 5,170 observations in all six ONE-STEP regressions.
(iii) The parameters are estimated over the period 1962–2006.
(iv) Once and twice lagged levels of the dependent and the independent variables are used as instruments (i.e. values of 1960 and 61 are used as instruments for 1962).
(v) ** and *** indicates that parameters are significant at 5% and 1%, respectively.

endangered species in a country and year) as a key measure of *Biodiversity* in a country (Daniel et al., 2008). The variable is published in the World Bank's World Development Indicators 2008 (World Bank, 2008) and linearly interpolated for missing years. The variable takes on the highest value (of 683) for Malaysia in 2004. The number of endangered species is <5 for 51 per cent of the countries and years. CO_2 EMISSIONS – measured in kilo-tons – also comes from the World Bank's World Development Indicators 2008 (World Bank, 2008).[3] There is one country-year observation for which CO_2 EMISSIONS takes on a negative value, Senegal in 1968. Otherwise, CO_2 EMISSIONS is positive throughout. In the sample covered, it takes on the highest value for China in 2006.

AGRRAW – reflecting agricultural raw materials exports in per cent of merchandise exports – is based on the World Bank's World Development Indicators 2008 (World Bank, 2008) and ranges from 0 to 88.74 per cent, with an average of 9.4 per cent. In the covered

[3] We ran alternative regressions using CO_2 emissions *per capita* and CO_2 emissions per GDP, and the corresponding results were very similar to the ones based on the proposed measure.

TABLE 4
Parameter Estimates with $E(y_{it}^c|y_{it-1}^c, x_{it}, v_i)$;$c$=*ATMOSPHERE*

	Atmosphere (Number of MEAs)	*Atmosphere (Number of MEAs)*	*Atmosphere (Number of MEAs)*	*Atmosphere (Number of MEAs)*	*Atmosphere (Number of MEAs)*
Lagged dependent variables					
$y_{it-1}^{ATMOSPHERE}$	0.3833***	0.4944***	0.5077***	0.4248***	0.3714***
$y_{it-1}^{NBMEA\neq ATMOSPHERE}$	0.0115***				
$y_{it-1}^{BIODIVERSITY}$		0.0180			
y_{it-1}^{LAND}			0.0168		
$y_{it-1}^{CHEMICALS}$				0.0295***	
y_{it-1}^{SEAS}					0.0266***
Economic determinants					
$LGDP_{it}$	0.4507***	0.5343***	0.4232***	0.4218***	0.4475***
$LPOP_{it}$	0.1053**	0.0783	0.0808	0.1252**	0.0934*
TRADE $LIBERAL_{it}$	0.5504***	0.5491***	0.4710***	0.5045***	0.5582***
INVEST $LIBERAL_{it\,it}$	0.0008	0.0044**	0.0061***	0.0021	0.0011
LDC	0.0600	0.2053	0.1996	0.1238	0.0766
Political determinants					
PFI_{it}	0.0325*	0.0371	0.0523**	0.0616***	0.0310*
Environmental determinants					
PLANT $SPECIES_{it}$	−0.0003	−0.0004	−0.0007**	−0.0006*	−0.0002
$AGRRAW_{it}$	−0.0079	−0.0089	−0.0112	−0.0084	−0.0075
CO_2 $EMISSIONS_{it}$	0.0495**	0.0589**	0.0582**	0.0613**	0.0399

Notes:
(i) *t*-Statistics in parentheses.
(ii) There are 110 countries and 5,170 observations in all six ONE-STEP regressions.
(iii) The parameters are estimated over the period 1962–2006.
(iv) Once and twice lagged levels of the dependent and the independent variables are used as instruments (i.e. values of 1960 and 61 are used as instruments for 1962).
(v) *, **, *** indicates that parameters are significant at 10%, 5% and 1%, respectively.

data, Nepal and Singapore display the highest values of AGRRAW in 1960, while Burkina Faso, Benin and the Central African Republic display the highest value in 2006.[4]

5. RESULTS

We organise the presentation of results in two subsections. While Section 5*a* summarises parameter estimates and their standard errors, Section 5*b* is devoted to the discussion of associated marginal effects.

[4] We employed the land area (in per cent of total land area), the forest area of a country (in per cent of total land area or in square kilometres) and a country's permanent cropland (in per cent of total land area) from the World Bank's World Development Indicators 2008 (World Bank, 2008) as possible alternatives to AGRRAW. However, these variables are much more collinear with the included covariates (especially, with CO_2 EMISSIONS and PLANT SPECIES) than AGRRAW is. Therefore, we prefer using AGRRAW instead of those alternatives.

TABLE 5
Parameter Estimates with $E(y_{it}^c|y_{it-1}^c, x_{it}, v_i)$;$c$=*LAND*

	Land (Number of MEAs)	*Land (Number of MEAs)*	*Land (Number of MEAs)*	*Land (Number of MEAs)*	*Land (Number of MEAs)*
Lagged dependent variables					
y_{it-1}^{LAND}	0.0264	0.0269	0.0263	0.0288	0.0327
$y_{it-1}^{NBMEA\neq LAND}$	0.0020***				
$y_{it-1}^{BIODIVERSITY}$		0.0068***			
$y_{it-1}^{ATMOSPHERE}$			0.0092***		
$y_{it-1}^{CHEMICALS}$				0.0046**	
y_{it-1}^{SEAS}					0.0016*
Economic determinants					
$LGDP_{it}$	0.1775***	0.2155***	0.2230***	0.1988***	0.2282***
$LPOP_{it}$	0.2521**	0.2321**	0.2457***	0.2546**	0.2256**
TRADE $LIBERAL_{it}$	0.1756*	0.1868*	0.1761*	0.1778*	0.1971*
INVEST $LIBERAL_{it}$	0.0019**	0.0027***	0.0012	0.0023**	0.0030***
LDC_{it}	−0.0495	−0.0119	0.0430	−0.0094	0.0023
Political determinants					
PFI_{it}	−0.0013	0.0003	0.0014	0.0033	0.0013
Environmental determinants					
PLANT $SPECIES_{it}$	−0.0002	−0.0003	−0.0003	−0.0003*	−0.0003
$AGRRAW_{it}$	0.0017	0.0006	0.0006	0.0008	0.0012
CO_2 $EMISSIONS_{it}$	−0.0082*	−0.0088*	−0.0088**	−0.0088**	−0.0106**

Notes:
(i) *t*-Statistics in parentheses.
(ii) There are 110 countries and 5,170 observations in all six ONE-STEP regressions.
(iii) The parameters are estimated over the period 1962–2006.
(iv) Once and twice lagged levels of the dependent and the independent variables are used as instruments (i.e. values of 1960 and 61 are used as instruments for 1962).
(v) *, **, *** indicates that parameters are significant at 10%, 5% and 1%, respectively.

a. Parameter Estimates

The models in Table 2 include the economic, political and environmental determinants along with the lagged dependent number of MEAs ratified. There are six columns: one for all MEAs and one for each of the five clusters. The associated results can be summarised as follows. First, the direction of a specific determinant's effect on the number of MEAs tends to be the same (with the occasional exception): higher levels of the lagged dependent variable, economic determinants and political (benefit) determinants affect the number of MEAs ratified positively, whereas environmental (cost) determinants, if they are significant, exert a negative impact on the number of MEAs. Second, the coefficients of the lagged dependent variable are positive and significantly different from zero throughout. Accordingly, adjustment dynamics are important for MEA ratification within and across clusters.

Third, LGDP and TRADE LIBERAL exert a large, positive and significant impact for all MEAs and all MEA clusters. Hence, economic size and multilateral trade liberalisation are the most important and robust drivers of MEA ratification within and across clusters. Fourth, the impact of investment liberalisation (INVEST LIBERAL), of political freedom (PFI) and

TABLE 6
Parameter Estimates with $E(y^c_{it}|y^c_{it-1}, x_{it}, v_i)$;$c$=*CHEMICALS*

	Chemicals (Number of MEAs)	*Chemicals (Number of MEAs)*	*Chemicals (Number of MEAs)*	*Chemicals (Number of MEAs)*	*Chemicals (Number of MEAs)*
Lagged dependent variables					
$y^{CHEMICALS}_{it-1}$	0.0671***	0.0739***	0.0723***	0.0774***	0.0648***
$y^{NBMEA\neq CHEMICALS}_{it-1}$	0.0073***				
$y^{BIODIVERSITY}_{it-1}$		0.0060			
$y^{ATMOSPHERE}_{it-1}$			0.0254***		
y^{LAND}_{it-1}				0.0059	
y^{SEAS}_{it-1}					0.0115***
Economic determinants					
$LGDP_{it}$	0.6899***	0.7467***	0.7137***	0.7229***	0.7032***
$LPOP_{it}$	−0.0397	−0.0287	−0.0275	−0.0292	−0.0382
TRADE $LIBERAL_{it}$	0.5507***	0.5827***	0.5443***	0.5705***	0.5735***
INVEST $LIBERAL_{it}$	0.0006	0.0048***	0.0002	0.0050***	0.0023**
LDC_{it}	0.0169	0.0841	0.0987	0.0756	0.0586
Political determinants					
PFI_{it}	−0.0409***	−0.0245*	−0.0278**	−0.0175	−0.035***
Environmental determinants					
PLANT $SPECIES_{it}$	0.0002	0.0001	0.0001	0.0000	0.0002
$AGRRAW_{it}$	−0.0041	−0.0050	−0.0053	−0.0053	−0.0042
CO_2 $EMISSIONS_{it}$	−0.0298**	−0.0261*	−0.0261*	−0.0270**	−0.0297**

Notes:
(i) *t*-Statistics in parentheses.
(ii) There are 110 countries and 5,170 observations in all six ONE-STEP regressions.
(iii) The parameters are estimated over the period 1962–2006.
(iv) Once and twice lagged levels of the dependent and the independent variables are used as instruments (i.e. values of 1960 and 61 are used as instruments for 1962).
(v) *, **, *** indicates that parameters are significant at 10%, 5% and 1%, respectively.

of emissions (CO_2 EMISSIONS) is often significantly different from zero but differs qualitatively across clusters.

Notice that the specifications in Table 2 do not distinguish between spillover effects associated with the ratification of MEAs from different clusters. In a next step, we shed light on such spillover effects by including the lagged dependent variable as in Table 2 along with the respective spillover variable as introduced in the second vertical bloc of Table 1. The respective results for each cluster are summarised in Tables 3–7. Hence, in addition to the impact of all MEAs ratified in clusters other than c on the number of MEAs in c, we also shed light on the role of spillovers from specific non-c clusters in Tables 3–7.

Tables 3–7 suggest the following conclusions. First, dynamic adjustment within a cluster is found to be important for all clusters except biodiversity and land. Spillover effects from all other clusters are found to be important throughout. Hence, there is contagion in the ratification of MEAs across issues. Economic size (LGDP) and multilateral trade liberalisation (TRADE LIBERAL) are found to be key drivers of the ratification of MEAs across the board also when conditioning on cross-cluster spillovers. Investment liberalisation appears to be

TABLE 7
Parameter Estimates with $E(y_{it}^{c}|y_{it-1}^{c}, x_{it}, v_i)$;$c$=*SEAS*

	Seas (Number of MEAs)	*Seas (Number of MEAs)*	*Seas (Number of MEAs)*	*Seas (Number of MEAs)*	*Seas (Number of MEAs)*
Lagged dependent variables					
y_{it-1}^{SEAS}	0.0899***	0.0903***	0.0947***	0.0924***	0.0914***
$y_{it-1}^{NBMEA\neq SEAS}$	0.0099***				
$y_{it-1}^{BIODIVERSITY}$		0.0303***			
$y_{it-1}^{ATMOSPHERE}$			0.0072		
y_{it-1}^{LAND}				0.0121	
$y_{it-1}^{CHEMICALS}$					0.0161**
Economic determinants					
$LGDP_{it}$	0.5556***	0.5790***	0.6448***	0.6439***	0.5779***
$LPOP_{it}$	0.1139	0.1283	0.1261	0.1367	0.1245
TRADE $LIBERAL_{it}$	0.3960***	0.4274***	0.4634***	0.4896***	0.4099***
INVEST $LIBERAL_{it}$	−0.0061***	−0.0033*	−0.0023*	−0.0019	−0.0047***
LDC_{it}	−0.0410	−0.0464	0.0501	0.0491	0.0074
Political determinants					
PFI_{it}	0.0833***	0.0791***	0.0842***	0.0841***	0.0840***
Environmental determinants					
PLANT $SPECIES_{it}$	−0.0014***	−0.0014***	−0.0012***	−0.0012***	−0.0014***
$AGRRAW_{it}$	−0.0185***	−0.0189***	−0.0177***	−0.0181***	−0.0182***
CO_2 $EMISSIONS_{it}$	0.0044	0.0061	0.0088	0.0036	0.0057

Notes:
(i) *t*-Statistics in parentheses.
(ii) There are 110 countries and 5,170 observations in all six ONE-STEP regressions.
(iii) The parameters are estimated over the period 1962–2006.
(iv) Once and twice lagged levels of the dependent and the independent variables are used as instruments (i.e. values of 1960 and 61 are used as instruments for 1962).
(v)* and *** indicates that parameters are significant at 10%, and 1%, respectively.

important for the clusters land and seas: while it stimulates ratifying MEAs in the former, it appears to deter ratifying MEAs in the latter.

Among the environmental fundamentals, a larger number of endangered species deters MEA ratification in particular for the clusters biodiversity and seas. A bigger percentage of agricultural raw materials exports in merchandise exports tends to reduce the incentive to conclude MEAs in the clusters biodiversity and seas. Interestingly, CO_2 EMISSIONS deters MEAs in the clusters chemicals and hazardous wastes and land, while they appear to stimulate MEAs in the cluster atmosphere.

b. Marginal Effects

The parameter estimates of the regression results in Tables 2–7 offer insights into qualitative, but not the quantitative, effects of the fundamental variables on MEA ratification. Let us augment this information by reporting a set of marginal effects in Table 8. In the interest of space, let us report marginal effects only for statistically significant parameters in the last five columns of Table 2 (corresponding also to the first columns of Tables 3–7). Moreover, let us report effects to one-standard deviation increases in the respective fundamental variables. In

TABLE 8
Marginal Effects of Explanatory Variables

	Biodiversity	*Atmosphere*	*Land*	*Chemicals*	*Seas*
Lagged dependent variables					
$y_{it-1}^{NBMEA \neq BIODIVERSITY}$	44.88				
$y_{it-1}^{NBMEA \neq ATMOSPHERE}$		40.70			
$y_{it-1}^{NBMEA \neq LAND}$			6.63		
$y_{it-1}^{NBMEA \neq CHEMICALS}$				21.24	
$y_{it-1}^{NBMEA \neq SEAS}$					21.85
Economic determinants					
$LGDP_{it}$	204.36	164.17	46.61	342.39	231.20
$LPOP_{it}$	*n/v*	16.52	44.19	*n/v*	*n/v*
TRADE $LIBERAL_{it}$	110.57	174.28	37.98	174.43	106.67
INVEST $LIBERAL_{it}$	*n/v*	*n/v*	3.59	*n/v*	−10.71
LDC_{it}	33.51	*n/v*	*n/v*	*n/v*	*n/v*
Political determinants					
PFI_{it}	*n/v*	6.57	*n/v*	−7.53	17.72
Environmental determinants					
PLANT $SPECIES_{it}$	−4.36	*n/v*	*n/v*	*n/v*	−14.44
$AGRRAW_{it}$	−10.94	*n/v*	*n/v*	*n/v*	−21.62
CO_2 $EMISSIONS_{it}$	*n/v*	24.83	−3.61	−12.50	*n/v*

Notes:
(i) Figures are percentage changes of MEA counts in response to a one-standard deviation increase in an explanatory variable. Marginal effects are calculated only for statistically significant parameters in the last five columns of Table 2. *n/v* means *no value* and fills the cells where the corresponding β-coefficients are not significant.

Table 8, we use *n/v* to indicate 'no value' for statistically insignificant coefficients in the last five columns of Table 2.

The marginal effects may be summarised as follows. First, economic size (LGDP) and multilateral trade liberalisation (TRADE LIBERAL) are the most important drivers of MEA ratification across the board. For instance, a one-standard deviation change in LGDP raises the number of MEAs ratified by in between about 47 (land) and 342 (chemicals and hazardous wastes). A one-standard deviation change in TRADE LIBERAL exerts a somewhat smaller effect on the number of MEAs ratified in all clusters except atmosphere. In comparison, the remaining marginal effects are negligible.

6. CONCLUSION

This paper analyses the impact of economic, political and environmental fundamentals on the ratification of multilateral environmental agreements (MEAs) in five different clusters of issues: biodiversity, atmosphere, land, chemicals and hazardous wastes, and seas. The results point to an overwhelming importance of economic size and multilateral trade liberalisation as drivers of MEA ratification across clusters. Other determinants have much smaller and in part even qualitatively ambiguous effects on the number of MEAs concluded. Apart from the mentioned fundamentals, adjustment costs and, even more so, spillovers from the ratification of MEAs across clusters are found to be important for the scope of participation in MEAs.

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