Democracy, International Interlinkages and Cooperation over Shared Resorces

Anna Kalbhenn

Doctoral Dissertation No. 18844
ETH Zurich

2010

DISS. ETH NO. 18844

DEMOCRACY, INTERNATIONAL INTERLINKAGES AND COOPERATION OVER SHARED RESOURCES

Dissertation submitted to

ETH ZÜRICH

for the degree of

Doctor of Sciences

presented by

Anna Kalbhenn

Dipl.-Verw.Wiss., Universität Konstanz

born 22.12.1980

citizen of Germany

accepted on the recommendation of

Prof. Dr. Thomas Bernauer, examiner

Prof. Dr. Simon Hug, co-examiner

Prof. Vally Koubi, co-examiner

Prof. Hugh Ward, co-examiner

2010

Acknowledgements

This thesis is the result of my research at the Center for Comparative and International Studies (CIS) at ETH Zurich and the Swiss National Research Program on Democracy in the 21st Century (NCCR Democracy).

I am indebted to my advisors Thomas Bernauer, Vally Koubi, Simon Hug and Hugh Ward for guidance, patience and support. Vally Koubi and Thomas Bernauer generously supported my intentions to attend various doctoral programs and summer schools to acquire additional skills and research methods, encouraged me to present my research at international conferences and created an academic environment from which I greatly benefited. Hugh Ward and Simon Hug provided important methodological and substantive advice that greatly improved the quality of this thesis. Simon Hug was always willing to answer my long e-mails with tricky methodological questions and spent large amounts of time trying to debug code on dynamic count models which we intended to use in one of the papers of this thesis. I also want to thank Hugh Ward for his exceptional hospitality during my research stay at the University of Essex. Our frequent, intense, and stimulating discussions of my research helped me to make important progress during decisive stages of this project. I further acknowledge his provision of data on indirect trade and IGO interlinkages and on "green demand". Hugh Ward also agreed to come to Zurich twice to present his work at an NCCR democracy workshop and to discuss one of my papers during the NCCR doctoral school's final workshop.

Special thanks go to Gabriele Ruoff, who not only gave valuable input for my work and supported me during different stages of this project, but has also become a close friend. Gabi was always there to help me, took over some of my tasks, when I was away on conferences or summer schools or simply too busy with other assignments. Our close collaboration and the constant discussion of our research was of great importance for this project. Tim Thomay deserves a big thank for providing me with the necessary infrastructure to run Matlab via a remote connection and for helping me with various Matlab problems. This did not only speed up estimation time, but also allowed me to continue estimation when my local copy of Matlab went out of memory. I am thankful to Aya Kachi and Jude Hays for providing Matlab code on m-STAR models and to Lena Schaffer for "proof-reading" my adjustments to this code. Further, I would like to thank Matthias Ganninger for the provision of his LaTeX-style file.

Warm thanks also go to Xun Cao, Bo Honoré, Han Dorussen, Kristian Skrede Gleditsch, Patrick Kuhn, and Vera Troeger for useful comments. Juliane Krueger gave much appreciated support with final proof-reading.

Marianne Furrer, Daniel Laupper, Joanne Richards, Bianca Sarbu, Maja Schaerer, Hannah Strohmeyer, and Stephan Suter have provided knowledgeable assistance in coding data on river events and environmental treaty characteristics. The Swiss National Science Foundation financially supported part of the data collection under grant 100012-120357, which is greatly acknowledged.

Participants of various conferences, the EITM summer institute, and the NCCR Democracy research colloquium gave valuable input on several of my papers. I thank the discussants (Gyung-Ho Jeong, Martin Gassebner, Christopher Gelpi, Nils Petter Gleditsch, Koji Kagotani, Lutz Krebs, Matias Margulis, Helen Milner, Tatiana Skripka, Elizabeth Smythe, Randall Stone, Michael Thies, Tancrède Voituriez, and Hugh Ward) and participants of these conferences and seminars and greatly appreciate their comments.

Last but not least, I thank my parents for continuous support.

Zusammenfassung

In dieser Dissertation beschäftige ich mich mit der politischen Ökonomie von Umweltpolitik; ein Schwerpunkt liegt auf grenzüberschreitende Ressourcen. Folgende Fragen stehen im Vordergrund: welchen Einfluss haben demokratische Strukturen und zwischenstaatliche Beziehungen auf Kooperation und Konflikt angesichts geteilter Ressourcen? Wählen politische Entscheidungsträger die Standorte von Messstationen und die Daten, die von diesen an internationale Agenturen übermittelt werden, strategisch aus? Wird globales Regierungshandeln, speziell der Beitritt zu multilateralen Umweltabkommen, stärker von nationalen oder von internationale Faktoren beeinflusst? Um diese Fragen zu beantworten, bediene ich mich unterschiedlicher, sich ergänzender Herangehensweisen, verschiedener Analyseebenen und mehrerer neuer Datensätze.

Ich beginne mit einem Literaturüberblick (mit Thomas Bernauer) zum internationalen Management von Frischwasserresourcen. Dabei zeigt sich einen klarer Trend von Fallstudien hin zu statistischen Analysen. Dennoch ist es, aufgrund fehlender quantitativer Daten, weiterhin schwierig, die Ursachen von Kooperation und Konflikt über geteilte Ressourcen zu untersuchen. Hier setzt der folgende Aufsatz an, der meinen neuen Ereignisdatensatz zu Kooperation und Konflikt in grenzüberschreitenden Flusseinzugsgebieten beschreibt. Im nachfolgenden Aufsatz benutze ich die Kooperations- und Konfliktdaten als abhängige Variable in einer Untersuchung zu Kooperation in grenzüberschreitenden Gewässern. Ziel dieser Studie ist, die Kontextabhängigkeit der angeblich friedensstiftenden Wirkung von Demokratie, und zwischenstaatlichen politischen- sowie wirtschaftlichen Verflechtungen genauer zu untersuchen. Ich verwende u. a. deshalb Ereignisdaten, weil die Vergleichbarkeit länderspezifischer Verschmutzungsdaten fraglich ist. Der vierte Aufsatz (mit Lucas Beck und Thomas Bernauer) beschäftigt sich mit ökologischen, ökonomischen, politischen und internationalen Bedingungen, die Wasserqualitätskontrollen und Datenberichterstattung beeinflussen. Unser vorrangiges Interesse gilt der Frage, ob Qualitätskontrollen und Datenberichterstattung auf strategischen Entscheidungen beruhen und ob dies einen Einfluss auf Datenqualität hat. Der letzte Artikel (mit Thomas Bernauer, Vally Koubi, und Gabi Ruoff) erweitert den Fokus hin zu generellen globalen Umweltthemen. Wir vergleichen hier internationale und nationale Ursachen globalen Regierungshandelns.

Die wichtigste praxisrelevante Schlussfolgerung dieser Dissertation: Beim Versuch, zögerliche Staaten zu motivieren, ihren Beitrag zu globalem Umweltschutz zu leisten, sollten internationale Gesichtspunkte stärker als bisher berücksichtigt werden. Wir sehen beispielsweise, dass die Wahrscheinlichkeit, einem Umweltabkommen beizutreten mit der Anzahl Länder, die dies bereits getan hat, steigt. Ähnlich positive Nebenwirkungen zwischenstaatlichen Verhaltens sehe ich in internationalen Flusseinzugsgebieten. Wenn sich beispielsweise Tansania und Sambia kooperativer am Kongo-Einzugsgebiet verhalten, ist auch mehr Kooperation zwischen Malawi und Botswana sowie zwischen Tansania und Sambia am Sambesi Einzugsgebiet zu erwarten. Politische Entscheidungsträger und Politikberater sollten also versuchen, in Sachen Umweltpolitk hinterherhinkende Länder generell stärker in das internationale System zu integrieren. Positives Verhalten von Referenzländern kann zudem bisher zögerliche Länder überzeugen, aufzuholen.

Diese Dissertation zeigt den wichtigen Einfluss sowohl internationaler als auch nationaler Faktoren auf Kooperation bei geteilten Ressourcen. Allerdings werfen die Ergebnisse auch einige weiterführende Fragen auf und deuten somit auf weitreichende Möglichkeiten für zukünftige Forschung hin.

Abstract

This thesis deals with the international political economy of environmental politics, with a special focus on the management of transboundary resources. It is organised around the following core questions: what is the impact of democratic structures and countries' interlinkages on cooperation and conflict over shared resources? Do governments strategically choose the location of measuring stations and the data reported to international agencies? What is the relative importance of domestic and international, and peer-group effects on global governance dynamics, in particular the commitment to multilateral environmental agreements? I use a variety of complementary approaches, different levels of analysis, and several new datasets to address these questions.

I start out with an assessment of existing scholarship on international management of freshwater resources (co-authored with Thomas Bernauer). This literature review shows that although recent empirical research on transboundary water issues has moved from case study evidence towards large-N quantitative studies, the main obstacle to comprehensive analyses of the determinants of cooperation and conflict over shared resources is the lack of data on the dependent variable. This is the point of departure for the following paper, which describes the construction of a new eventdataset on transboundary river basin cooperation and conflict. The subsequent paper uses the cooperation and conflict intensities as the dependent variable in a study on cooperation over shared resources. The aim of this paper is to shed light on the context-dependency of the allegedly pacifying effects of democracy, political- and economic interlinkages. One of the reasons why I consider water related events rather than outcomes such as water quality is the question of comparability of country-level data. Paper four, co-authored with Lucas Beck and Thomas Bernauer, deals with environmental, economic, political and international conditions that are driving differences in environmental monitoring activity and data reports. The main concern is whether the measuring and reporting of water quality are based on strategic considerations and if so how this impacts data quality. The last paper, co-authored with Thomas Bernauer, Vally Koubi, and Gabi Ruoff, expands the view by moving beyond water related issues to global environmental concerns more generally. In particular, the paper compares international and domestic sources of global governance dynamics.

The main policy implication is that efforts to motivate laggard countries to contribute to global environmental politics should not exclusively focus on domestic attributes, but consider international context factors. We observe that the likelihood of treaty ratification increases with the number of countries that have already ratified a certain treaty. In a similar vein, I find positive spill-over effects both within river basins and country pairs; i.e., if Tanzania and Zambia behave more cooperatively the Congo basin, we also expect more cooperation between Malawi and Botswana and between Tanzania and Zambia on the Zambezi basin. Policymakers and policy advisors wishing to get reticent countries on board may thus focus on involving these countries in more general terms. In addition, cooperative behaviour by peer countries may motivate others not to stay behind.

This volume clearly reveals important links between both international and domestic factors on cooperation over shared resources. However, the findings also raise several additional questions and therefore indicate ample scope for future research.

Contents

List of Figures

List of Tables

Chapter 1

Introduction

This thesis addresses several questions concerning the international political economy of environmental politics, with a special focus on the management of transboundary resources. In recent years, international environmental issues have gained increasing importance on the global policy agenda and are no longer regarded as "low politics". Evidence of this can be found when considering the topics dealt with by many international organisations, such as the World Bank, the WTO, or the OECD, to name but a few. International environmental issues such as climate change are also featuring more prominently at high-level international meetings, such as G8 summits and are thus receiving increasing media attention. One important aspect in this context is that many resources are not confined to the national territory but cross international borders. This has lead to the establishment of environmental treaties and agreements at the global level, but also gives rise to informal arrangements and bilateral meetings of government representatives. Not surprisingly, we observe differences in intergovernmental interaction: the level of cooperation and conflict between resource-sharing countries varies both over time and across countries; certain countries commit themselves to many environmental treaties, whereas others are reluctant to become involved at the global level, and some countries are very good "citizens" when it comes to providing environmental data, while others lag behind international standards. This thesis addresses several international determinants and country characteristics that might account for this variation.

The dissertation is organised around the following core questions: what is the impact of democratic structures and countries' interlinkages on cooperation and conflict over shared resources? What role does context conditionality in terms of asymmetries (geography), citizens' concern and affectedness (problem characteristics) and the cost of cooperation (economic considerations) play in bilateral interactions? Do governments strategically choose the location of measuring stations (for water quality) and the data reported to international agencies? What is the relative importance of domestic (unit-internal) or international (unit-external) and peer-group effects on global governance dynamics, in particular the commitment to multilateral environmental agreements? I use a variety of complementary approaches, different levels of analysis, and several new datasets to address these questions.

One of the topics dealt with in this dissertation are transboundary freshwater issues. While the global freshwater supply is constant, increasing population density, economic activity and unsustainable water management practices have led to overexploitation of many freshwater resources. Furthermore, changes in water resources are one of the most prominent physical effects of climate change. In particular, climate models forecast long-term changes in precipitation and run-off, but also predict more extreme events, such as floods and droughts occurring more frequently than they did in the past. Such unprecedented hydrological changes bring about changes in socio-economic systems. In case of transboundary watercourses in particular, both the frequency and the degree of conflict and cooperation over shared water resources might change. Social science research has contributed in important ways to identifying sources of conflict and cooperation as well as water management options and institutional solutions that can facilitate sustainable international water management.

The first paper, co-authored with Thomas Bernauer, assesses existing scholarship on interna-

tional management of freshwater resources. It thus paves the way for future research by depicting the current state of affairs and identifying potential research gaps. In this paper, we review key contributions to the large body of literature on international water conflict and cooperation, considering both case study work and large-N studies. A combination of rising human populations and increasing contamination of freshwater by pollution have inspired claims that supplies of freshwater are so scarce that assuring access to freshwater will become a major source of conflict, including war, in coming decades. Several authors doubt, however, that there is sufficient evidence for the so-called 'water wars' hypothesis, arguably the most sensational hypothesis in this literature. We review key contributions that analyse whether water-related factors influence the probability of armed conflict, as well as papers that identify the factors that increase (or reduce) the probability of water-related conflicts short of war. Closely linked to water-related conflicts are questions about cooperation over shared resources. We review several studies that analyse the determinants of international river basin cooperation, in terms of both policy output and policy outcome. Furthermore, we delve into the literature on river treaty design, i.e. papers dealing with the determinants of particular institutional design principles and their impact and effectiveness in terms of problem solving. Moving beyond the mere description of design features, we also consider work that assesses whether international water management efforts are successful in terms of solving problems that motivate cooperation.

The literature review supports the conclusion that escaping the Malthusian trap of constant supply and increasing demand is feasible although generally there are no quick fixes for transboundary river management problems. Rather, international management of freshwater resources can be improved by carefully analysing the problem and assessing a range of different options for action. Despite the fact that the success of a particular attempt at joint river management crucially hinges on the specific political, economic, social, and geographic context, several remedies exist: a strong and competent international river commission, the involvement of all principal stakeholders, and a joint search of a fair (equitable) solution often lead to more stable cooperative arrrangements.

The literature review presented in the first paper shows that recent empirical research on transboundary water issues has moved from case study evidence towards large-N quantitative studies (cf. Brochmann & Hensel 2009*b*, Gerlak & Grant 2009, Tir & Ackerman 2009, Stinnett & Tir 2009*a*). Nevertheless, the main obstacle to comprehensive analyses of the determinants of cooperation and conflict over shared resources is the lack of data on the dependent variable. This is the point of departure for the following paper, which describes the construction of a new dataset on transboundary river basin cooperation and conflict based on event data derived from local newspapers worldwide.

The dataset described in this paper primarily aims to extend and complement existing data-projects, such as the Transboundary Freshwater Disputes Dataset (TFDD). One feature in this respect is that – in contrast to the TFDD – the new dataset provides information on both events and non-events. Currently, it is unclear whether non-events in the TFDD are due to the fact that no water events occurred in a given time period for a certain basin or whether the respective basin-years are (not yet) coded. Further, I code several additional variables. For instance, the TFDD indicates in how far an event is of cooperative or conflictive nature, but does not offer information on how salient it is. The current dataset provides information on salience (taking

into account citizens' concern as expressed in the respective press articles), the direction of action, additional information on the information sources (i.e. location and neutrality/ independence) and indicates whether certain events are linked to other events. Another aspect is that the TFDD is based on information provided by the Foreign Broadcast Information Service (FBIS). Comparing coding results based on the FBIS and BBC-Monitoring for a random sample of the same rivers and years, I found that BBC-Monitoring offers larger coverage in terms of local newspapers. Hence, the dataset presented in paper two is based on BBC-Monitoring rather than FBIS.

The construction of this dataset is an important cornerstone of my dissertation and provides the basis for answering several research questions regarding transboundary water management. I hope that this dataset will contribute to a better understanding of transboundary water management, not only because of the results presented in the following paper, but also through the provision of a new dataset that can be used by scholars interested in related questions.

Descriptive statistics based on the new dataset confirm the common perception (cf. Wolf 1998, Stucki 2005) that cooperative events outweigh conflicts over shared water resources. Nevertheless, there is considerable variation in the conflict and cooperation intensities of recorded events. Whereas more events are reported on certain large basins, there appears to be no bias in terms of certain country-pairs having more interactions over their shared rivers than others. Nor is there a time trend in the sense of observing considerably more (both in terms of quantity and quality) events in certain time periods than others.

Whereas paper two is limited to a detailed description of the new events dataset, the subsequent paper uses the cooperation and conflict intensities as the dependent variable in a study on cooperation over shared resources. The aim of paper three is to shed light on the context-dependency of the allegedly pacifying effects of democracy, political- and economic interlinkages (the Kantian[1] triangle). Whereas some authers note the context-dependency of the determinants of intergovernmental cooperation (cf. Russett 1994, 28), very few empirical studies explicitly take into consideration under which circumstances democracy, political- and economic interlinkages lead to more intergovernmental cooperation. Rather than simply relying on standard liberal theories (emphasizing the pacifying effect of democracy and interlinkages), I develop a theoretical argument highlighting the different circumstances under which democracy and interlinkages might have a cooperation-enhancing effect. Democratic leaders' willingness to cooperate might, for instance, depend on the cost of cooperation. I thus argue that democratic leaders have an incentive to cooperate over shared resources as long as the costs of cooperation (e.g. abatement costs) are outweighed by supporters' loyalty. Whereas both political and economic integration are expected to foster intergovernmental cooperation, their effect is expected to differ depending on power and interest asymmetries. Furthermore, certain problem characteristics, such as salience and severity are expected to have a different impact on cooperation, given different levels of democracy. On the one hand, severity increases abatement costs and thus reduces governments' incentives to react. On the other hand, salience might encourage democratic governments to take action in order to avoid electoral punishment. For democratic regimes, I expect that cit-

[1] The gist of the Kantian peace argument is that democracies do not fight each other. Extensions of the argument include liberal explanations in more general terms, emphasising the pacifying effects of democracy, economic interdependence and international organisations (cf Russett & Oneal 2001)

izens have easy access to information and thus become aware of environmental problems. In autocratic regimes, in contrast, even very severe environmental problems might not be affected by salience, since citizens are simply not informed about the issue. In addition, even if public awareness is high, autocratic leaders have fewer incentives to respond to their citizens' demands, since these politicians are relatively independent of their citizens' loyalty. Consequently, autocratic governments are expected to be reluctant to react to severe problems, whereas democratic leaders are expected to take action as long as the salience of the problem is high. We can thus differentiate between context factors related to geography (e.g. upstream/downstream situation versus border-demarcating rivers) and those referring to problem characteristics (salience and severity).

I empirically test my theoretical claims based on the event data described in paper two and several third party datasources (such as dyadic IGO membership by Pevehouse et al. (2004*b*)). The dependent variable is transformed along the lines suggested by Crescenzi & Enterline (2001) to account for the dynamics in interstate interaction. The main idea behind this transformation is that interstate relationships (with respect to shared river basins) are defined by previous interactions, whose influence on the perceived current interstate relationship depends on how much time has passed between such interactions, the accumulation of occurrences of conflict and cooperation, and on current cooperative and conflictive 'shocks', i.e. events that take place between two states at time t.

Given that I expect the action of a particular country pair neither to be independent of the behaviour of other countries in the same basin, nor to be independent of its action regarding other shared basins, I introduce basin and dyadic spatial weights in the form of contemporaneous spatial-weights matrices. I then estimate a multiparametric spatiotemporal autoregressive (m-STAR) model using the spatial maximum likelihood estimator (S-ML) proposed by Hays et al. (2009). S-ML jointly estimates the exogenous, non-spatial, effects and temporal and spatial interdependence (the former via the introduction of the lagged dependent variable).

My findings support the claim that democracies behave more cooperatively in managing shared freshwater resources. However, the effect is non-linear: whereas cooperation levels increase with democracy, once a certain threshold is reached, the effect dampens. There is clear empirical evidence that issue salience is an important driver of interstate relationships with respect to shared freshwater resources. In contrast to my theoretical expectation, the effect of salience is stronger in autocracies than in democracies. As expected, we observe geographic context conditionality: the affectedness of an upstream country is an important determinant of its relationship with downstream riparians. High affectedness leads to more cooperation with the effect being stronger for democracies than for autocracies. Furthermore, in accordance with the Kantian triangle, political integration fosters cooperative behaviour. The effect of economic integration, however, is less clear. In general, the results support the expectation that Kantian peace arguments are applicable in the context of shared resources, but the effect of democracy and interlinkages depends on context factors such as geography. The main implication to be drawn from this paper is that - so far - there is no empirical support for the water war hypothesis. In contrast, cooperation outweighs conflict, but the nature and degree of cooperation vary both within and across countries and basins. The most robust predictor for cooperation levels is the joint membership in international organisations. With respect to policy implications, successful strategies for joint management should thus consider riparians political ties and not

merely focus on basin characteristics.

One of the reasons why I consider water related events rather than outcomes such as water quality is the question of comparability of country-level data. Comparisons of environmental performance across countries have become very popular, and international agencies and scientific institutions compile and provide large amounts of data for such purposes. We often tend to assume that such data are adequately measured and accurately reported to international agencies. A cursory look at various sources of environmental information reveals that data coverage for most environmental indicators varies very strongly across countries and time. The main reason is that international datasets rely primarily on information that governments and their agents decide to collect and make available. The willingness and ability of governments to do so clearly differ across environmental issues, countries, and time. Such difference in the quality and data availability make cross-country comparisons of environmental performance difficult. Paper four, co-authored with Lucas Beck and Thomas Bernauer, deals with environmental, economic, political and international conditions that are driving differences in environmental monitoring activity and data reports. The main concern is whether the measuring and reporting of water quality are based on strategic considerations and if so how this impacts data quality. Effective monitoring and data provision are essential for effective environmental policy. The analysis of reporting activity therefore contributes to a better understanding of the factors that are important in motivating improvements of countries' environmental behaviour.

Prioritising depth over breadth, we limit the empirical analysis to water quality monitoring in Europe. Besides reasonably good data availability, focusing on this monitoring network reduces unit heterogeneity. European countries are, in global comparison, rich, and the European Environment Agency (EEA) coordinates and sets standards for water quality monitoring and reporting. Using data from the European Environment Agency, and other sources we set up a GIS that contains information on the location of several thousand active monitoring stations in Europe. We then examine whether and to what extent the spatial and temporal distribution of reported monitoring stations is driven by domestic factors, international interlinkages and basin specific characteristics.

Our sample includes observations for up to 41 countries[2], 328 river basins, and 40 years (1965-2005). We use three different specifications of the dependent variable. In the first specification, the dependent variable is defined as the number of active (reporting) monitoring stations per country, river basin and year. The second specification considers international stations, defined as those stations that are located on an international river within 10km from an international border. The third specification refers to domestic stations, i.e. all stations that are not defined as international. All models are estimated using negative binomial regressions with country fixed-effects.

According to our empirical results, domestic characteristics and basin-specific aspects play an important role in explaining compliance with the EEA standards. Both the effects of democracy and GDP per capita are clearly positive, and so is the size of a basin. Whereas peer countries appear to positively impact a given country's behaviour, other unit-external factors perform less

[2] This number varies over time since the number of independent states in Europe has changed during our period of investigation.

well in explaining countries' reporting behaviour: neither the IGO variable nor membership of international environmental agreements is statistically significant for the sample of international stations or the aggregated sample of stations.

From a policy-viewpoint, some results may give cause for concern: EU membership has a consistently negative effect on monitoring; and while, generally, monitoring activity increases over time, it decreases in the run-up to the Water Framework Directive (in force since 2000).[3] Other results draw a more positive picture. For instance, population density has a statistically significant, positive effect on reported monitoring. To the extent that population density can serve as a proxy for environmental pressure, more extensive data reporting from river systems exposed to greater environmental pressure is desirable.

Focusing on the number of monitoring stations reporting to the European network can offer initial insights into the extent of monitoring and reporting. It does not tell us how many and what types of pollutants these stations measure, and how often (within any given year). This limitation is due to the fact that construction of a dataset for the number of reporting stations is in itself a complex and time-consuming task. The analysis could be expanded to look not only at the location of monitoring activity, but also at what types of pollutants are measured when and where. We are quite confident, however, that the findings reported in this paper will be similar when studying the specific contents of data reporting. Ideally, such research could also establish what data from what location and at what time-intervals would have to be collected and reported in order to generate a truly representative or accurate picture – from an ecological and public health viewpoint – of national or aquatic system-specific environmental performance.

The last paper, co-authored with Thomas Bernauer, Vally Koubi, and Gabi Ruoff, expands the view by moving beyond water related issues to global environmental concerns more generally. In particular, the paper compares international and domestic sources of global governance dynamics. Existing empirical work on international cooperation emphasises domestic aspects, such as democracy or per capita income. In this paper, we examine the relative importance of countries' political and economic integration, peer-group effects, and domestic characteristics in predicting global cooperation.

Based on standard trade theory, we expect countries that trade intensively (economic integration) to be reluctant to commit themselves to environmental treaties. The argument is that environmental regulations, such as those put forward in multilateral environmental agreements, act like a tax on exportables. In other words, the more intensively a country trades, the greater the loss from a reduction in trade. Consequently, the trade-off between gains from a cleaner environment and losses from lower exports is more adverse for more open economies. With respect to political integration, we expect countries that behave more cooperatively in general terms also to do so when it comes to environmental commitments. Regarding unit-external factors such as the ratification behaviour of other countries (contingent behaviour), we expect that countries mimic what their peers do. That is, the probability of a country ratifying a particular treaty is expected to increase with many - or a particular group of - other countries doing so. We further consider domestic factors such as democracy and per capita income, both of which

[3] The Water Framework Directive is at the core of EU water legislation, aiming at providing a general framework for water protection and management.

we expect to positively influence a country's propensity to ratify a particular treaty.

We use a new dataset on global environmental treaties, that is, treaties that are open for ratification by all countries globally, and consider the ratification behaviour of 180 countries towards 255 global environmental treaties between 1950 and 2000. The data analysis relies on a binary-times-series-cross-sectional (BTSCS) approach as proposed by Carter & Signorino (2009). We then study the effects of country-external and country-internal determinants of international co-operation side-by-side, and systematically compare their (relative) importance.

As expected, integration into the world economy affects cooperative behaviour and the evolution of global environmental governance negatively. All other international factors have a stronger, and positive, impact on cooperative behaviour than domestic factors. The main implication of these results is that explicitly considering interdependencies might increase the explanatory value of empirical models in the realm of international politics. Models that ignore that any given country's behaviour is also shaped by the extent to which it is embedded in the international system, and by how specific other countries behave, might thus be mis-specified. With respect to policy implications, a noteworthy result is that once a certain threshold of countries that have ratified a treaty is reached, the probability that a particular country ratifies that treaty increases. Therefore, laggard countries might be motivated by other countries moving ahead with ratification. In addition, integrating reticent countries in more international organisations of any type can be helpful in promoting the formation of specific global governance systems.

Further research should address the question, whether these empirical relationships also hold in the context of other issue areas or whether they are specific to the realm of international environmental politics and multilateral environmental agreements in particular.

Throughout all the papers, we find a cooperation-enhancing effect of democracy. This effect is robust to different model specifications within the papers but also holds across the different issue areas and settings analysed. In addition, the same holds true for political interlinkages (measured by membership in international organisations) in the case of both multilateral environmental agreements and bilateral actions regarding transboundary rivers. Interestingly, results are less clear when it comes to economic integration. In this respect, we find clear evidence that countries that trade more intensively join fewer multilateral environmental treaties. However, bilateral trade interlinkages are – under most circumstances – related to better intergovernmental relationships over shared freshwater resources, and the effect of trade intensity on water quality reporting is unclear. It thus appears that the applicability of standard liberal claims hinges on the dependent variable analysed. Whereas cooperative behaviour that does not seem to have any apparent direct impact on the price of exports (such as the joint management of shared rivers) is positively linked to cooperation, standard trade theory best explains countries' behaviour when it comes to multilateral environmental treaties whose regulative implications might act as a tax on exports. An important implication for future research is thus that the applicability of standard liberal explanations (establishing a positive link between trade and cooperation) is highly context-dependent.

The findings of this dissertation contribute to the existing literature in several respects. First,

prior research in this area is dominated by single case studies. The main bottleneck for large-N empirical studies is the lack of good quality data. Each of the empirical papers of this dissertation draws on a new dataset. The most comprehensive effort in this respect was the construction of a new event dataset on cooperation and conflict over shared rivers. The subsequent paper on water monitoring activity in Europe relies on a new GIS set-up of data provided by the EEA. My co-author, Lucas Beck, has fixed problems regarding geographically undefined stations, refined the definition of river basins and manually coded whether or not a monitoring station is to be regarded as domestic or international. These efforts greatly improve pre-existing data on water quality monitoring and reporting in Europe. Finally, we analyse global governance dynamics, relying on a new dataset on global environmental treaty ratification. These data draw on data provided by Mitchell (2008*a*) and CIESIN (2006). We have merged both datasets and carefully examined the resulting sample to avoid double countings, excluded treaties that only marginally deal with environmental issues and eliminated those that are not open for ratification by all countries globally. In a follow-up paper – not part of this volume – we go a step further by explicitly coding treaty characteristics based on the legal text of each treaty in the sample.

Second, the dissertation uses different levels of analysis and thus goes beyond typical country-year analyses. As such, papers 2 and 3 deal with yearly data on basin-country pairs. This allows for the inclusion of monadic, dyadic (country-pair) and basin-specific covariates and adds to former studies that are often aggregated to the country or dyad level (cf. Gerlak & Grant 2009, Tir & Ackerman 2009). In a similar fashion, the joint analysis of domestic and international determinants of cooperation complements the existing literature on global governance that has often mainly emphasised domestic variables. Our finding that unit-external factors are the main drivers of global environmental governance underscores the importance of jointly considering unit-internal and unit-external variables.

Third, the papers deal with closely related but empirically distinct phenomena and thus allow for a tentative comparison of the effect of different explanatory variables under different circumstances. As alluded to before, the studies have shown that we need to carefully distinguish different contexts when considering the (allegedly positive) effect of trade intensity on cooperation, and indicate that Kantian peace arguments relating democracy to cooperation hold across different issue areas, samples, and specifications.

Notwithstanding these contributions to existing research, I consider certain limitations worth mentioning. A general issue of concern for any empirical study is data quality. I have always tried to gather the best data available and to use the most adequate operationalisation for the theoretical concepts whenever possible. Especially for the new datasets, I have run several plausibility- and cross-checks and recoded dubious data entries. Nevertheless, certain drawbacks pertain and in a few instances I had to sacrifice precision due to feasibility constraints. For instance, the population density figures used in the analysis of paper three are time-invariant, because no time-variant data on the basin level are currently available. The same applies for the landuse statistics used in the analysis of water quality monitoring in Europe (paper four). In addition, the data on water quality reporting in paper four partly rely on backward reporting. We do not believe that this has any systematic impact on our analysis.

With respect to the econometric methods employed, a major drawback is that the analysis of wa-

ter quality monitoring in Europe only partly takes time-dependencies into account. Research on dynamic count models has gained importance in recent years (cf. Brandt et al. 2002, Windmeijer 2008, Trivedi & Munkin 2009), but most of the proposed estimators are not yet satisfactorily implemented in any statistical software, nor is the code provided by some authors (Brandt et al. 2002, Windmeijer 2002) easily adaptable for our analysis. We have, therefore, used several alternative estimation techniques to assess the robustness of our results to different econometric approaches.

Regarding the empirical results presented above, there are some aspects that merit further investigation. One of them is the persistently negative effect of membership of the European Union on water quality reporting. A possible explanation for this finding is that member countries feel less pressure to demonstrate themselves as "good citizens" than those countries that still aspire to become member states. Future research could extend the analysis by more indepth expert interviews to gain additional insights on the findings provided by the statistical analysis. Such additional qualitative research might also provide an explanation for the negative impact of membership of international organisations on reporting behaviour. In the context of the work presented in this volume, this finding is especially intriguing given that the other two analyses (cooperation/conflict over shared rivers and global governance dynamics) find a consistent and very robust positive effect of membership of international organisations.[4] Prospective work should spell out more carefully the mechanism linking political integration (operationalised via membership of international organisations) to cooperation in certain issue areas such as the environment. Further research could also move beyond the rather simple operationalisation of political integration as membership of international organisations and focus on more sophisticated indicators for the position of countries in international political networks (cf. Ward 2006).

Additionally, future research should explore whether the core findings of this dissertation are applicable beyond the respective empirical focus of each paper. As such, our understanding of global governance dynamics would benefit from a comparison of the impact of countries' interlinkages with the international system and domestic factors on commitments to global agreements dealing with other issues than environmental politics. Similarly, one might analyse whether we observe strategic reporting of environmental indicators other than water pollution, such as air quality, or even move beyond the realm of environmental issues.

The main policy implication to be drawn from this dissertation is that efforts to motivate laggard countries to contribute to global environmental politics should not exclusively focus on domestic attributes, but consider international context factors. Paper five in particular has shown the importance of unit-external effects: the likelihood of treaty ratification increases with the number of countries (or countries in the peer-group) that have already ratified a certain treaty. In a similar vein, paper three indicates positive spill-over effects both within river basins and country pairs. That is, if Tanzania and Zambia behave more cooperatively regarding the Congo basin, we also expect more cooperation between Malawi and Botswana (other Congo riparians) and between Tanzania and Zambia on the Zambezi basin. Policymakers and policy advisors wishing

[4] This positive impact of IGO membership even extends beyond environmental commitments to environmental quality in developing countries (Ruoff 2009*a*).

to get reticent countries on board may thus focus on involving these countries in more general terms and may also rely on cooperative behaviour by peer countries to motivate others not to stay behind.

Summing up this dissertation's main findings, this volume clearly reveals important links between both international and domestic factors on cooperation over shared resources. However, the findings also raise several additional questions and therefore indicate ample scope for future research.

Chapter 2

The Politics of International Freshwater Resources

Thomas Bernauer, Anna Kalbhenn

ISA Compendium Project, Blackwell Publishing Ltd.

2.1 Introduction

Freshwater systems offer unique opportunities for addressing key questions of international conflict and cooperation. In practical terms, freshwater is one of humanity's most valuable and vulnerable natural resources. Surface waters, such as rivers and lakes, which are the most accessible sources for human consumption and use, constitute only a tiny fraction of the water on earth. The world's 35 x 106 km^3 of freshwater constitutes only 2.5% of its total water (1,365 x 106 km^3). Only 0.3% of all freshwater is stored in rivers and lakes; 30.8% is stored in groundwater, and 68.9% in glaciers and permanent snow cover (most of it in inaccessible places, such as Antarctica). Around 42,000 km^3 of the approximately 110,000 km^3 of precipitation over land is river runoff (UNEP at `www.unep.org/dewa/assessments/ecosystems/water/vitalwater/freshwater.htm`).

While the global freshwater supply is constant, increasing population density, economic activity, and unsustainable water management practices have led to overexploitation of many of the more easily accessible freshwater resources at local and regional levels. Many of these resources cross international boundaries. Notably, more than 260 river basins covering around 45% of the earth's continental landmasses span two or more countries. Some areas of the world suffer primarily from acute water scarcity. Others suffer more from pollution. All of these problems have direct implications for human health, ecosystems, and socioeconomic development more generally (Gleick et al. 2006).

Escaping the Malthusian trap of constant supply and increasing demand is feasible if societies can put in place appropriate institutions and technologies (Dinar et al. 2007). Social science research has contributed in important ways to identifying sources of conflict and cooperation as well as water management options and institutional solutions that can facilitate sustainable international water management.

From an academic perspective, international freshwater systems are interesting objects of study because they lend themselves to systematic comparison. They are shared by relatively small groups of countries (around two to ten). The natural resource and the problems associated with it are, in most cases, clearly circumscribed, and there are many such freshwater systems around the globe that can be compared. The large literature on international water conflict and cooperation, to which political scientists and researchers from related disciplines have been contributing to a growing degree, is testimony to the importance of the issue.

We review key contributions to this literature, beginning with a general description of important issues and questions in international water management, and then working our way through the main questions addressed by the existing literature:

1. Is there sufficient evidence for the "water wars" claim, arguably the most sensational hypothesis in this literature? That is, do water-related factors influence the probability of armed conflict? Or, if the water wars claim turns out to be exaggerated, what are the

factors that increase (or reduce) the probability of water-related conflicts short of war?

2. What are the determinants of international river basin cooperation, in terms of policy output and policy outcome or impact?

3. How are cooperative efforts to solve river basin conflicts designed? What are the determinants of particular institutional design principles?

4. How can we assess whether international water management efforts are successful in terms of solving problems that motivate cooperation?

5. To what extent does the literature offer insights into institutional design options that are effective in terms of problem solving?

A literature review of moderate length requires inconvenient tradeoffs. We could have covered a very large number of publications from different disciplines of the social sciences and humanities. But this would have come at the expense of specificity. We opted for greater depth rather than maximum scope. As a result, many (but hopefully not too many) interesting publications must go unnamed. Moreover, we focus largely on contributions by political scientists, leaving out a large body of international water management literature produced by scholars in law, economics, anthropology, and related disciplines.

2.2 The Issue

The obstacles to sustainable management of domestic water resources are often formidable. But water allocation, pollution, and other problems on international rivers appear to be particularly daunting. The sovereignty of states, the key organizing principle in international politics, means that there is no political unit above and beyond the state that could impose solutions (e.g. allocation rules, prohibitions, pollution thresholds) on unwilling nations.

Legal norms, through which victims of water scarcity, water pollution, or other water-related problems might seek remedy, are generally weaker at the international than the domestic level (e.g. Conca 2006, Dinar 2006). The same holds for international bodies that are authorized to adjudicate in cases of conflict (e.g. the International Court of Justice). In regard to international waters, basic principles of international law exist, but in practice they provide only very general guidance for resolving specific transboundary water problems (e.g. Marty 1997, Salman & Boisson-de-Chazournes 1998). Marty (1997, 17) notes that "the golden rule of water law [...] says that there is no golden rule." In other words, institutional structures for reconciling conflicting interests at the international level tend to be less sophisticated and less resilient to opportunistic behavior than their domestic counterparts. Solutions need to be achieved through negotiations among riparian countries under conditions that, in many parts of the world, resemble a self-help system.

Motivated by the practical importance of the issue (see, e.g. Gleick 1998), research on international freshwater issues carried out by natural scientists and engineers has produced an enormous body of literature. Although many of these contributions are very important, they cannot provide conclusive explanations of success and failure in international freshwater management. New technology is obviously important for escaping the Malthusian predicament; but in most cases, the most serious obstacles to successful international freshwater management are not primarily technical, but rather political and economic. Answers to when and why international water management efforts succeed or fail must then, to a large extent, be found through the study of conflict and cooperation, which are social rather than technological phenomena.

The UN Food and Agricultural Organization (FAO) has counted several thousand treaties on international water issues since the eighth century. Wolf (1997, for updates see TFDD) has identified around 450 international treaties on non-navigational issues of water management, flood control, hydroelectric projects, and allocations for consumptive and nonconsumptive uses of international rivers since 1945. These "real world experiments" offer great opportunities for observational studies that seek to test theory-derived explanations of water-related conflict and cooperation. Though the criteria for measuring performance (or effectiveness) of cooperative efforts remain disputed (see below), a large number of case studies on individual international rivers and lake management indicate that some institutions work quite well and problems are in fact solved, whereas others appear to fail (e.g. Le Marquand 1977, Marty 1997, Dinar & Dinar 2003).

Until the end of the 1990s the literature on international water management was mainly of the "lessons learned," prescriptive, or pure theory type (cf. Chapman 1963, United Nations 1975, Fox & Le Marquand 1978, Vlachos et al. 1986, Frey 1993, World Bank 1993, Barrett 1994, Rangeley 1994, Kilgour & Dinar 1995, Ganoulis et al. 1996, Nakayama 1997, Elhance 1999, Holtrup 1999, Shmueli 1999, Beach et al. 2000). Recent work has focused on developing more coherent and theory-driven explanatory models. The vast majority of observational studies designed to empirically assess an explicit set of theory-based hypotheses are single case studies. However, an increasing amount of large-N research on the subject has appeared since the turn of the century. This new large-N literature is important in that it helps in assessing the external validity of many of the claims made in the qualitative case study work.

The scope of the following literature review is limited primarily to two areas. First, we put somewhat more emphasis on large-N comparisons than on qualitative case studies because the movement towards large-N studies has been the most visible innovation in this literature in recent years. Moreover, reviews by Dinar et al. (2007), Dinar & Dinar (2003), Bernauer (2002), and Marty (1997) have already summarized the findings from the qualitative case studies literature quite extensively. Second, we concentrate on international rivers because they have attracted far more attention in the political science literature than international lakes or groundwater resources.

2.3 Water-Related Conflict

The literature on international water issues reflects the major themes that also appear in other areas of the International Relations literature. One part of the water literature deals with the causes of conflict at varying scales of intensity, the most radical version being the claim that water problems can be a cause of armed conflict. We discuss this area of research at this point. The next section looks at studies focusing on the causes of international cooperation. Some recent work suggests that conflict and cooperation should be studied jointly rather than separately (Zawahri & Gerlak 2009, 218) because both might occur simultaneously in the same river basin. Nonetheless, because only very few authors have so far followed this path (examples include Wolf, Yoffe & Giordano 2003, Brochmann & Hensel 2009*b*, Warner & van Buuren 2009, Zawahri 2009) we discuss studies on conflict and cooperation separately.

Many case studies analyze the conditions that lead to water-related conflict in individual river basins. For example, Kibaroglu (2002) examines the Euphrates–Tigris basin, Lowi (1993*a*) and Wolf (1995) the Jordan River, and Howell & Allan (1994) the Nile. Other work, for example by Wolf (2006–2008), Marty (2001), Allan (2001), Amery & Wolf (2000), and Blatter & Ingram (2001), is comparative and uses sets of case studies. An extensive survey by Dinar & Dinar (2003, see also Dinar et al. 2007) summarizes findings from many of these case studies. We agree with them that these studies are very valuable. Many of them offer highly interesting accounts of economic, social, political, and physical conditions that lead to the overexploitation of river systems and conflict among riparian countries. Even though there are of course always case-specific, idiosyncratic causes at work, the general picture that emerges from these studies is that conflict is more likely when:

- due to anthropogenic influences or natural processes water becomes more scarce and/or more polluted (i.e., the costs of environmental degradation are felt more strongly by politically important constituencies in riparian countries);
- an upstream–downstream setting entices the upstream country to exploit its positional power and discriminate against downstream neighbors;
- non-water conflicts among the riparian countries exacerbate water-related conflicts;
- political and economic ties among the riparian countries are weak;
- the financial, institutional, or administrative capacity of key riparian countries is poor;
- water-related international institutions in the river basin are weak.

Factors such as these account quite well for why transboundary water management problems and associated conflicts are much harder to solve in cases such as the Nile, Jordan, Euphrates, Tigris, Amur, Syr Darya, or Mekong than in cases such as the Great Lakes and Rio Grande in North America and the Rhine, Danube, and Rhone in Europe.

When the Cold War ended many policy makers became more aware of potential nonmilitary threats to international peace and security. In this context, and in view of the UN's 1992 Rio summit on sustainable development, water issues began to attract considerable public attention. Statements such as "The wars of the next century will be over water" (Ismail Serageldin, former vice president for environmentally sustainable development of the World Bank, in a 1995 press release) started to make headlines (see also Cooley 1984, Bulloch & Darwish 1993). Some academics jumped on the bandwagon. Hughes Butts (1997), for example, states that "History is replete with examples of violent conflict over water, from competition for desert oases and water holes to the battles between the Mesopotamian cities of Lagash and Umma in 4500 B.C., to the fighting between Syria and Israel over Syria's attempts to appropriate the headwaters of the Jordan River in the 1960s." However, most of the academic community involved in case study work on international water issues was quick to recognize that such statements were hardly backed by empirical evidence. But at that point in time, there simply was no large-N data that could be used to expose the water wars claim to a serious test.

Gleick (1993), one of the pioneers in this field, identifies possible water conflict scenarios based on historical examples. He develops three categories of water-related conflict: water resources as military and political goals (Gleick 1993, 84), water resource systems as instruments of war (Gleick 1993, 87–88), and links between other conflicts and water developments, such as consequences of dam constructions (Gleick 1993, 93). In most of Gleick's historical examples water scarcity does not appear to be at the core of the conflict but tends to figure as one of several elements of conflict. The same applies to Hughes Butts's (1997) work in this area. He contends that "water conflict is most likely when rivers are shared by multiple users and downstream users are vulnerable to decisions made by upstream states" (Hughes Butts 1997, 70). But he does not offer a coherent theoretical explanation and empirical evidence for this claim. Similarly, Homer-Dixon (1994) regards depletion and pollution of fresh water supplies as a possible cause of violent conflict, but does not provide systematic empirical evidence.

One of the most important achievements of social sciences research in the international freshwater realm in recent years has been to establish large-N datasets and systematically test the water wars hypothesis. Such research started in the late 1990s (e.g., Mandel 1992 studies conflict in 14 river basins). It has materialized in two forms that can be distinguished by the type of dependent variable. The first introduces water-related factors into existing explanatory models of armed conflict. The second relies on events data that measures water-related conflicts more directly.

The first line of research initially concentrated on whether sharing an international river makes a difference in terms of increasing the probability of armed hostilities between countries. There are two reasons why sharing a river could play a role in determining a country dyad's (pair of countries') risk of experiencing interstate war, the most extreme type of conflict between states. First, upstream–downstream situations might induce conflicts related to resource scarcity (cf. Gleditsch et al. 2006). Second, due to natural processes, riverbeds can change over time. This might cause conflict if a river constitutes the border between two countries and this border becomes contested when the riverbed changes (Furlong et al. 2006). 2006). Gleditsch and his

co-authors, as well as Furlong et al., call this problem "fuzzy boundaries" (Gleditsch et al. 2006, Furlong et al. 2006). Both Gleditsch et al. and Furlong et al. find empirical evidence in favor of the claim that, controlling for other determinants of war, sharing a river increases the risk of armed conflict, but they do not find robust support for the fuzzy-boundary hypothesis (Gleditsch et al. 2006, 379).

The main difficulty with the work by Gleditsch, Furlong, and their co-authors is that it remains silent on whether conflicts experienced by countries that share a river were actually linked to freshwater issues. The dependent variable in these studies is the "onset of militarized interstate disputes (MID) with a minimum of one fatality," based on data from the Correlates of War project (Gleditsch et al. 2006, 367). This data does not include any information on whether conflicts are directly linked to freshwater issues or merely happen to occur between river-sharing countries. The link to transboundary water issues as a cause is made through statistical inference, that is, by using geography (sharing a river) as the main explanatory variable while controlling for other determinants of armed conflict.

Arguably, sharing a river and plain geographical contiguity (having a common border) are highly correlated. In fact, most countries that have a common border share at least one river, but countries might share a river without bordering each other if the river flows through intermediary countries. Consequently, the conflict-enhancing effect of sharing a river might reduce to an artifact of contiguity. To exclude this possibility, citetTos00 explicitly take contiguity into account when examining whether sharing a river increases the probability of interstate armed conflict. They find an independent, albeit very small effect of river sharing. Moreover, contiguity has a bigger effect on the risk of interstate conflict than sharing a river. This work offers some support for the earlier results on the relationship between transboundary rivers and interstate conflict. However, the particular definition of the dependent variable can provide only very indirect evidence on whether water is actually the cause of any armed conflict observed, and genuine river-sharing effects remain very difficult to separate from simple gravity effects (geographic proximity, common border).

The "Issue Correlates of War Project" (ICOW) has produced more direct evidence on whether or not conflicts are water-related. The ICOW data captures all reported events including "evidence of contention involving official representatives of two or more nation-states" (Hensel 2005). That is, it tells us whether an official of either country in a dyad makes an explicit claim regarding the use of an international river by expressing demands concerning the quality or quantity of river water.

Hensel et al. (2006) and Brochmann & Hensel (2009*a*) use this data to explore the causes of river claims, their aggravation (becoming militarized) and resolution, and the success rate of negotiations over river claims. They find that water scarcity and asymmetry of capabilities in a country dyad aggravate conflict and reduce the probability of successful negotiations, whereas freshwater treaties are conducive to resolving river claims. Furthermore, greater water demand and a generally cooperative relationship between riparians are associated with successful ne-

gotiations over river claims, notably in case of current rather than future river-related concerns (Brochmann & Hensel 2009*a*). These results are consistent with findings by Mitchell & Hensel (2007) and Hensel et al. (2008), who study the circumstances of conflict settlement agreements in more general terms (territorial, maritime, and river claims) based on the ICOW dataset. Surprisingly, recent militarized conflict appears to have a positive effect on the probability of ending a river claim. Moreover, the value of a river to a country (navigational or irrigational value, presence of hydroelectric projects, river passes by major population centers) is positively correlated with attempts at peacefully settling a river claim (Hensel et al. 2006). But it also increases the likelihood of militarized settlement attempts (Hensel et al. 2008, 137).

As of mid 2009, the ICOW river data was still being collected and existing studies were based on data for the Americas, northern and western Europe, and the Middle East. Whether the early findings reported above are supported within a global dataset remains to be seen. In any event, the work by Brochmann, Hensel, Mitchell, and coauthors is very insightful in that it uses a very sophisticated dependent variable, systematically relates it to a wide range of determinants of conflict, and considers conflict and cooperation jointly.

The second line of research, as mentioned above, concentrates on events data that was collected (coded) by Wolf et al. (2005) in the Transboundary Freshwater Disputes Database (TFDD) project. This data captures "reported events of either conflict or cooperation between nations over water resources during the last 50 years" (Wolf, Yoffe & Giordano 2003, 29). Yoffe et al. (2003, 2004), Wolf, Stahl & Macomber (2003), Wolf, Yoffe & Giordano (2003) and other authors have used this data as a dependent variable. One of their main goals has been to identify "basins at risk," i.e., international river basins likely to experience political stress in the near future (Wolf, Yoffe & Giordano 2003).

The conclusions of this work are (1) that cooperative events by far outweigh conflictive events over shared water, and (2) that "The likelihood and intensity of a dispute rises as the rate of change within a basin exceeds the institutional capacity to absorb that change" (Wolf, Yoffe & Giordano 2003, 51; see also Wolf et al. 2005). More specifically, the likelihood and intensity of disputes rise when population density is high, income is low, overall relations between countries are unfriendly, there are politically active minority groups, large dams or other water development projects are planned, and there are limited or no freshwater treaties. Yoffe et al. (2004) find, furthermore, that, at least in the Middle East, South Asia, and Southern Africa, both water conflict and cooperation at the international level correspond to similar events at the domestic level. Giordano (2002) arrives at similar results, concluding that "water-related events at the national level are related to both water and nonwater events at the international scale" (Giordano 2002, 79). According to this work, the majority of basins at risk are located in southern Asia and central and southern Africa. They include the following freshwater systems: Ganges–Brahmaputra, Han, Incomati, Kunene, Kura–Araks, Lake Chad, La Plata, Lempa, Limpopo, Mekong, Ob (Ertis), Okavango, Orange, Salween, Senegal, Tumen, and Zambezi.

The ex post evidence discussed so far disconfirms the water wars hypothesis. However, as

noted by Wolf (1998), this result should not mislead us into thinking that conflicts over freshwater are de facto irrelevant: "while water wars may be a myth, the connection between water and political stability certainly is not. The lack of a clean freshwater supply clearly does lead to instability which, in turn, can create an environment more conducive to political or even military conflict". The nature of these relationships and the extent to which they are present, however, appear to vary considerably by country and region. This result highlights not only the intricacies of hydro-political dynamics and their variation across geographic space, but also the need to consider the often distinct historical and political conditions within a region or basin if water relations are to be well understood."

In other words, international water war predictions turn out to be largely political rhetoric. But serious non-militarized international disputes over water issues exist and may well increase in frequency in future, particularly in areas hard hit by climate change and population growth. Water scarcity and pollution are not primary causes of domestic wars/conflicts. Rather, societies that are vulnerable in multiple ways (e.g., due to ethnic tensions, poverty, weak institutions, a history of violent conflict, resource (water) scarcity) can be thrown into violent conflicts through triggers not related to water. Such conflict, in turn, can exacerbate preexisting resource scarcity problems. Darfur is a good example.

Diagnostic research has made considerable progress in identifying key drivers of international river basin conflict. These results facilitate "risk profiling." Events data is particularly useful in this respect. A corollary of this research is that well-designed international river basin institutions may not prevent conflict altogether, but they impose "bounded competition"; i.e., they constrain processes of escalation and thus help in mitigating conflict. This leads us to research on water-related cooperation.

2.4 Water-Related Cooperation

Cooperation cannot be fully explained by simply focusing on the inverse values of explanatory variables that account for conflict, even though many case studies and some large-N data discussed in the previous section offer important insights also into the causes of cooperation. As in the preceding section we begin with a review of key results from the comparative case studies literature and then move to a review of recent large-N work.

The pioneer in this area of research is Le Marquand (1977). Using a unified analytical framework he studied the Colorado salinity issue, the High Ross Dam controversy, the development of the Columbia River, and Rhine water quality problems. His list of explanatory variables is rather long and only loosely connected to political science and economic theories. Similarly, the empirical testing of propositions is, from a methodological viewpoint, rather cursory, but still, the conclusions rest on more systematic empirical analysis than conclusions offered by previous research.

Le Marquand's findings are: (1) Riparians are better able to solve their problem if they have common perceptions of the problem, if win–win solutions are created, and if national leadership is committed to solving the problem. (2) Economic optimization is less important for cooperation than non-economic factors. (3) Cooperation is more successful when social concerns and objectives are evaluated and defined in the planning process, and when consequences and costs of alternative strategies are assessed in detail. (4) Cooperation is more successful when agreements are flexible enough to adapt to changing values, technologies, and market conditions. (5) Reciprocal interests in cooperation are most conducive to problem solving, whereas upstream–downstream problems are the most difficult ones to deal with. Third parties, such as international organizations and donor countries, can be instrumental in overcoming the latter type of problems.

Subsequent comparative case study research has by and large confirmed these conclusions, though it has also produced a lot of additional insights (cf. Wolf 1997, 1998, 2006–2008). Durth (1996) and Marty (2001), for example, have revisited the hypothesis that cooperation is less likely in upstream–downstream situations than in situations characterized by more symmetrically distributed environmental damages. Their and other authors' work shows that even under the more adverse upstream–downstream condition cooperation is still possible if specific socioeconomic conditions are present and particular policy tools are applied. Waterbury (1997, 280) indeed notes that "International relations theory, as well as a good deal of economic theory, would warn us of the difficulties of achieving cooperative solutions to multi-player games in which the actors are sovereign and the pay-offs to cooperation asymmetrical. Asymmetrical rewards always characterize the potential outcomes of cooperation in international river basins. [...] those with the least to gain will retain veto power over cooperative solutions. They must be compensated by those who stand to gain the most, and it is no easy task to arrive at compensatory schemes when the beneficiaries of cooperation are not sure of what they will gain nor the losers of the extent of their potential losses. The indifferent may prefer the familiarity of the status quo to the uncertainties of binding cooperation."

Durth (1996) offers a very systematic argument on when and why riparian countries are likely to overcome upstream–downstream asymmetries and engage in cooperation. His principal hypothesis is that such problems are easier to solve when riparian countries are more "integrated," i.e., when the density of political, economic, and social ties among countries is greater. He claims that efficient cooperation is more likely in more integrated settings because: (1) compensation of upstream countries, which is needed to motivate the latter to cooperate, is easier; (2) integrated settings enable riparian countries to make more credible commitments to one another because they interact in a larger number of policy areas; (3) information is likely to be more complete and evenly distributed; (4) notions of equity or justice are more likely to be congruent; (5) unequal bargaining leverage is mitigated by transboundary institutions, which also allow for more clearly defined, transferable property rights and lower transaction costs; and (6) opportunities for nongovernmental (including private) actors to influence outcomes are greater. Using descriptive statistics for a sample of 127 agreements (involving a total of 35 countries plus the EU) from 1852 to 1992, Durth concludes that the evidence, especially for upstream-downstream cases, confirms his principal hypothesis.

In contrast to Durth, Marty (2001) finds that concerns over equity (or fairness) may be as intense in more integrated as in less integrated settings; moreover, he shows that such concerns can arise and stall international efforts even when there is no substantial cost–benefit asymmetry in the material (economic) sense. This finding receives support from a book by Blatter & Ingram (2001, see also Ingram & Blatter 2000), in which the authors explore the range of subjective meanings and values that water has in different social contexts. They claim that, in many places, water is essential for the existence and identity of social actors and serves as a focal point for community building. They postulate that when riparian actors' connection to water is "essentialist" or even fundamentalist, policy processes "cannot be captured by game theory based on the assumption of strategic action. Neither perceived threats to national security nor fundamental value conflicts allow for 'rational' solutions like side payments or package-deals" (Blatter & Ingram 2001). Blatter and Ingram do not systematically test this hypothesis. The empirical evidence produced by Durth and Marty suggests, however, that fairness concerns of riparians that are unrelated to material (economic) costs or benefits can indeed complicate international efforts to resolve upstream–downstream problems through compensation, issue linkage, or other policy instruments.

Marty concludes that joint research, joint development and implementation of solutions, jointly owned infrastructure, and third party input of know-how can help in overcoming obstacles to cooperation. Another of his important findings is that cost–benefit asymmetries often exist at the local level, rather than at the national level, in riparian countries. One of the key questions, then, concerns the conditions under which local interest groups are able to engage their respective national governments in international negotiations on the issue. The analysis of the Alpine Rhine flood control, the Colorado salinity, and the Tijuana sanitation cases demonstrates that transforming an issue from an inter-local to an international problem can foster progress in two ways: first, a wider set of possible issue linkages for changing the incentives of uncooperative actors is available at the international level; second, national governments' capacity to fund projects is bigger. The Colorado case illustrates both these mechanisms. Hardest to solve are, in Marty's view, problems plagued by a "double asymmetry," i.e., strong differences of interest between riparian countries and, within those countries, between local actors and their national governments. The Tijuana case comes closest to the "double trouble" situation, followed by the Alpine Rhine case in some phases. In contrast to Durth, Marty finds that compensation of the more unwilling participants – by either national governments, other riparians, or third parties (e.g., non-riparian countries or international financial institutions such as the World Bank) – is crucial to cooperation in many cases.

Recent case studies challenge the realist view that cooperation is more likely when the downstream country is the hegemon and less likely if the upstream country is the strongest riparian (Daoudy 2009, Dinar 2009*a*). Dinar agues that rather than power in a realist sense (military and economic capabilities), "issue specific structural power in asymmetric contexts highlights how otherwise weaker parties are able to extract concessions from more powerful states" (Dinar 2009*a*, 330). Basing his argument on in-depth study of several treaties over international river basins with an upstream and others with a downstream hegemon, he concludes that issue linkage, reciprocity, and side-payments are key to achieving collaborative solutions in asymmetric contexts. Similarly, Daoudy (2009, 382) concludes that "power asymmetries have paradoxically

favored upstream/downstream interactions towards bilateral if not basin-wide agreements" in negotiations on the Euphrates and Tigris basin. Both authors claim that a weaker downstream state may constrain the basin-dominant riparian's alternatives by acting on the latter's interests and thus invert situations of power asymmetries.

Using a "hydropolitical" framework of analysis proposed by Dinar (2000), Kempkey et al. (2009) analyze treaty formation in the La Plata river basin in terms of "(1) power relations, interdependencies, and regional politics; (2) protracted conflicts and domestic politics, and; (3) likely benefits from cooperation" (Kempkey et al. 2009, 256). Comparing the successful negotiation in the La Plata case to the situation in other transboundary basins (Aral Sea, Nile), the authors conclude that the following features of negotiation in the La Plata basin might explain their relative success: (1) no external mediation, which sometimes increases transaction costs (time, lack of breakthrough, (2) establishment of institutions as a very first step, (3) focus on development projects rather than water allocation, and (d) vague language in terms of the form of cooperation agreed upon Kempkey et al. (2009, 275–275).

Large-N datasets developed since the late 1990s have allowed researchers to explore the extent to which some important insights from case studies on individual rivers are relevant to a larger number of international water systems. As noted in the section on water-related conflicts, events data collected by Wolf et al. (Wolf 1998, Wolf, Stahl & Macomber 2003, Wolf, Yoffe & Giordano 2003) demonstrates that cooperative events outnumber conflictive events by far. This evidence is very much in line with many case studies, including those on basins with particularly high conflict potential, such as the Nile and the Euphrates/Tigris (e.g. Stroh 2004, Stucki 2005).

In view of such compelling evidence, supporters of the water war hypothesis have retreated to the claim that water-related wars may still occur in some river basins at some point in the future (a claim that is impossible to test), or they have noted that water-related conflicts take place at the domestic rather than the international level (cf. Homer-Dixon 1994, 19). Stucki (2005) asks "why, in the face of a clear epistemic consensus in academia in favour of the 'water peace' hypothesis, the public discourse retains its belief in the threat of interstate conflict over water" 2005, 5. He concludes that there are two main reasons. First, the water peace hypothesis is more complex and thus more difficult to communicate than the water war hypothesis 2005, 67. Second, water war is likely to gain more attention than water peace, which is why the media can gain more by reporting on the former 2005, 67. This latter point may also be a source of bias in the academic literature, where case studies cluster strongly on the "hottest basins," such as the Jordan, the Nile, and other particularly conflictual cases (see also Wolf, Yoffe & Giordano 2003, 32).

While the large-N data on water events and treaties tells us that cooperation is the rule rather than the exception, inferential statistical research on the causes of cooperation is still at an early stage. Some of this research focuses on international river treaties as the dependent variable. Other research looks at the flipside of the conflict hypotheses discussed in the secton "Water-

Related Conflict" above and combines events and treaty data.

Using data from the Transboundary Freshwater Disputes Database (TFDD) project, Espey & Towfique (2004) estimate the probability that two countries sharing a river will conclude a water-related bilateral treaty. The sample includes 118 bilateral water treaties from 1944 to 1998 and also covers 157 international river basins where no bilateral treaty exists. The biggest effects emanate from geography. The larger a river basin as a share of the country's territory, the more likely is this country to join a bilateral agreement. The opposite effect dominates if a country controls a larger share of the basin than the other country in a dyad. Whereas income and income differences between countries have no significant effect, trade ties have a small, positive effect on the probability of treaty formation. Similarities in culture, government, and language have only weak effects.

Song & Whittington (2004) concentrate on international river treaty formation as well, using TFDD and data by the Food and Agriculture Organization of the United Nations (FAOLEX). Their sample includes 200 international rivers and 122 treaties since 1950. The explanatory variables pertain to geography (location on particular continents, river geography), types of civilizations, and similarities/differences in economic size, income, and population. The authors observe more treaty formation in basins with states that differ more in terms of their GDP and population size. Basins with multiple "civilizations" are no less likely to have treaties, though rivers in the "Western civilization" are more likely to have treaties. Upstream–downstream geography makes treaty formation less likely.

A somewhat similar study by Tir & Ackerman (2009) analyzes the conditions under which riparian countries enter into treaties dealing with water quantity and quality. They find that both joint democracy and riparian interdependence increase the likelihood of treaty formation. This study is very sophisticated in illuminating the effects of country characteristics on cooperation. However, it aggregates the data up to the country dyad level (rather than the river basin country dyad). This prevents the analysis of river basin-specific effects. In contrast to Tir & Ackerman (2009), Gerlak & Grant (2009) use the river basin (implicitly defined by its riparian countries) as the unit of analysis. They examine 63 institutional arrangements in 245 international river basins between 1975 and 2000. They find that institutional arrangements are more likely to be established in basins shared by multiple countries (more than two) and between predominantly democratic riparians with asymmetrical military capabilities (Gerlak & Grant 2009, 29). The depth of institutional arrangement is best explained by existing formalized organizational structures and strong economic capabilities.

Brochmann & Gleditsch (2006b) examine whether sharing a river induces cooperation between states. They find that country dyads sharing a river basin cooperate more than other dyads. Cooperation is measured by joint membership in international organizations and bilateral trade volume. Joint membership in international organizations and trade are obviously rather crude proxies for cooperation and do not inform us whether cooperation is related to shared rivers. In another paper, Brochmann & Gleditsch (2006) refine their concept of cooperation by analyzing

the determinants of freshwater treaty participation. They focus on the relationship between water events (using data from the TFDD) and the signing of freshwater treaties to study whether previous water events lead to treaty signing and whether dyads that have signed a freshwater treaty are more prone to engage in cooperative events after the signing of a freshwater treaty. The empirical results show that water-related events stimulate the signing of freshwater treaties and that the number of water-related events between countries increases once a treaty has been signed. Surprisingly, this effect appears to be independent of whether the events are of a cooperative or conflictive nature.

Whereas the large majority of studies concentrate on policy output (treaties, events) a few authors have also addressed policy outcomes, i.e. the factors that determine how much countries in international river basins harm each other environmentally. Sigman (2002, 2004) is among the very few scholars who have looked at the effect of trade relations on externalities in international water systems (measured by organic pollution in this study). She argues and finds some evidence that states do free-ride on their neighbors. But she also finds that trade promotes environmental cooperation among states in several ways: by providing opportunities for implicit side-payments, thus allowing for linkages between environmental and trade concessions; by providing direct leverage over other countries' production; and by installing a perception of shared goals.

Similarly, Bernauer & Kuhn (2009) explore whether there is an environmental version of the Kantian peace in international river basins. That is, they examine whether democracies that trade and are bound by international treaties are less likely to harm each other environmentally. To that end, they focus on five factors that are likely to help in reducing beggar-thy-neighbor behavior in terms of transboundary pollution: democracy, supranational institutions, trade relations, stringency of domestic environmental policy, and international environmental commitment. Their dataset includes observations on upstream–downstream water pollution in Europe from 1970 to 2003. The observed effects of the five variables differ across forms of pollution and definitions of beggar-thy-neighbor behavior. Some of the explanatory variables contribute to reducing beggar-thy-neighbor behavior. Hence there is some empirical support for the environmental Kantian argument. The authors conclude, however, that "state behavior in this area remains characterized by free-riding incentives; the forces of democracy, trade, and national and international regulation and institutions do not easily produce decent international behavior." By and large, this finding lines up well with previous case study work. The latter demonstrates that cleaning up transboundary upstream–downstream pollution is usually a long and cumbersome process, even among rich and democratic countries. Examples include the Rhine, Oder, Elbe, Colorado, Rhone and many other transboundary rivers in Europe and North America.

2.5 Design Principles of International Freshwater Management Institutions

As suggested by studies on transboundary water pollution (see above), "real" progress in sustainably managing international rivers requires more than the mere existence of treaties, international organizations, or other political events or structures. Not surprisingly then, policy makers are often interested primarily in how cooperative arrangements should be designed so that they have a positive (problem-solving) effect on riparian behavior and the environment. We start by discussing some findings that have emerged from qualitative case studies and then move to recent large-N research on institutional design in international water cooperation.

Marty's (2001) book contains one of the most extensive analysis of institutional design features and their effect on success/failure in international river management. The finding likely to spark the most debate among policy makers and ecologists is Marty's conclusion that integrated river basin management, though desirable in ecological terms, has in practice failed. He argues that international river basin institutions that focus on a small number of core issues and detailed and operational regulations tend to be more effective. This conclusion is vulnerable to criticism because it may suffer from selection bias: all cases studied by Marty are cases of specific (functional) river management. His claim would have been more defensible had he also explicitly studied attempts at integrated river management. The available evidence in fact suggests that many if not most attempts at integrated river management have failed (e.g., Gambia River Development Agency, Niger Basin Authority, Lake Chad Basin Commission, Kagera Basin Organization, Zambezi Action Plan; see Lee & Dinar 1995, Dinar & Dinar 2003, Dinar et al. 2007). Though the population of integrated international river management efforts remains unknown, it appears that failure is most common in sub-Saharan Africa. A more sophisticated analysis of this proposition would need to take into account the level of development of riparian countries, their geographic region, political stability, and other variables.

Other design features that Marty (2001) and other authors (e.g Dinar & Dinar 2003) associate with successful river management include: "feasibility," i.e. match between objectives and available resources and know-how; "flexibility," i.e. adaptive capacity of cooperative arrangements in view of changing interests of riparians and changing scientific knowledge and environmental problems (Drieschova et al. 2008); effective organizational structures, notably well-run professional international river commissions (Zawahri 2009) and effective inter-administrative relations; close ties between international river commissions and national-level authorities; and "openness," i.e. involvement of nongovernmental stakeholders and subnational political units.

The principal difficulty with these findings is empirical, that is, to disentangle the effects of institutional features, such as specificity, from the effects of antecedent cooperation problems (e.g. upstream–downstream vs. common pool resources). Most research designs in fact operate with two assumptions that are not explicitly discussed. The first assumption is that the problem structure (e.g. upstream–downstream), as well as political efforts (negotiations among riparians) to deal with it, result in a non-empty "win set," the latter denoting the range of possible

bargaining outcomes that each of the participants regards as preferable to the status quo (non-agreement). The second assumption is that policy makers can make better or worse choices within this win set. This analytical distinction is rarely congruent with the real world of politics. For example, the lack of specificity that is associated with failure of the problem-solving effort may simply be the result of riparian countries' inability to come to terms with a difficult upstream–downstream situation in the first place, rather than inability of policy makers to get the institutional design right. For example, existing studies do not clearly tell us whether or not, in the Colorado salinity case, it was the upstream–downstream problem or the attempt of some policy makers to broaden the range of issues to be tackled that produced delays in solving the problem.

Though very narrow in terms of their empirical focus, Verweij (1999, 2000*a*,*b*,*c*) and Tschanz (2001) offer interesting insights into one specific institutional design feature: voluntary vs. government-imposed pollution reduction rules. That is, both authors focus on the effect of variation over time in one regime design principle on environmental outcomes in one international river management case (Rhine). While this approach does not permit generalizations beyond the case studied, it is commendable for its methodological rigor; it enables the authors to focus on a single and important hypothesis while holding conditions exogenous to the explanation (e.g., the nature of the environmental problem, the number and level of development of riparians, the institutional setting) constant.

Verweij and Tschanz examine whether voluntary pollution reduction measures (notably in regard to heavy metals), adopted by industry along the Rhine, have been more effective than government-imposed national and international measures (notably, the Rhine Action Program and earlier agreements). Verweij (2000*a*,*b*,*c*) claims that industry made large-scale voluntary investments in water protection and thus reduced water pollution before the imposition of reduction measures by governments and the Rhine Commission. Voluntary measures implemented by industry (in addition to domestic political measures) are, in his view, primarily responsible for the dramatic reductions in heavy metal and other pollution of the Rhine. Verweij's conclusion rests primarily on data demonstrating the industry's overcompliance with international pollution control standards. Tschanz argues that Verweij's interpretation of the available data is, in part, incorrect. Correcting for such errors, he arrives at the opposite conclusion: that government-imposed measures (national and international) have contributed more to reducing heavy metal pollution of the Rhine than voluntary measures. Further analysis will be required to determine whose conclusions are, in light of the available evidence, more accurate. Findings of this nature are interesting not only from an academic but also from a policy perspective.

A recent study by Zawahri (2009) emphasizes the important role that third party mediators can play in resolving international river disputes and establishing stable institutions. She argues that mediators can contribute by assisting in implementing (and monitoring) a treaty, coordinating riparians and the donor community and establishing an effective joint river commission. Successful mediation is illustrated by a case study on the Indus River.

Studies by Dombrowsky (2007), Dombrowsky (2006), and Conca et al. (2006*a*) are the first to use large-N approaches to study institutional design principles in international water management. Dombrowsky (2007) draws on a wide range of (mainly political economy) theories to study institutional design issues in international water management. The empirical analysis is based on information for several hundred international river treaties and several qualitative case studies. Dombrowsky's work is very useful because it systematically connects theoretical discussion of problem structures to institutional solutions.

She observes that international agreements exist in around 40% of all international river basins, and that international river basin organizations have been set up in 60% of the basins where an agreement exists, or around 25% of all basins. Interestingly, she notes that side-payments and issue linkages, which one would expect to be used quite frequently when unidirectional externalities in upstream–downstream settings exist, are rare. Only 9% of the 506 agreements analyzed include financial transfers and only 6% include non-water issue linkages. She notes, however, that intra-water issue linkages materialize more frequently. Dombrowsky also shows that of 86 international river basin organizations in the sample, 50% have neither monitoring nor enforcement provisions, and that only 10% have some kind of enforcement provisions in place.

The authority of existing river management organizations is, on average, very much constrained. That is, the character of river basin cooperation remains strongly in the intergovernmental rather than the transnational or supranational realm. Moreover, in the case of some existing organizations that are equipped with a rather broad range of functions, such as the Organisation pour la mise en valeur du Sénégal, their de facto authority and effectiveness are very much in doubt. Finally, the majority of agreements deal with more than one water-related issue area, but the concept of integrated water resources management (IWRM), which postulates a basin-wide approach that covers all relevant problems simultaneously, is very rarely applied in practice. For example, only around 20 percent of international river basins with more than two riparian countries include all riparian countries.

A more recent study by Stinnett & Tir (2009*b*) examines why some river treaties are more institutionalized than others. Their main argument is that institutionalization is most valuable when river issues are complex. In such cases, member states are willing to bear the cost of greater institutionalization (vs. more flexibility), because they benefit from higher problem-solving potential. Their empirical study, focusing on three major aspects of institutionalization, namely monitoring, enforcement, and conflict resolution mechanisms, provides support for this claim.

Shlomi Dinar 2006 concentrates on one particular institutional design issue that is also covered (albeit in less depth) by Dombrowsky: side-payments and cost sharing. Assuming that states are rational utility maximizers, we should expect such institutional design principles to be used particularly in upstream–downstream settings in order to motivate the upstream country to cooperate.

Using data for 91 international freshwater treaties from 1906 to 2000, S. Dinar finds evidence that side-payments occur more often in upstream–downstream settings. He also finds that in geographically more symmetric settings costs are more equally shared. However, the supporting evidence pertains largely to water quality issues and river development agreements and is not supported for water quantity issues. The author also observes that when economic (income) differences are taken into account, the direction of side-payments is reversed (the upstream pays the downstream country); or, in geographically more symmetric settings, the richer state bears most of the burden. An extended version of Dinar's research, which contains a lot of very useful data, was published in book form in 2008.

The fact that Dombrowsky and S. Dinar arrive at different empirical findings with respect to side-payment (or compensation) is striking and raises important questions for further research. The two authors use different empirical definitions of side-payments, somewhat different datasets, and different approaches in their data analysis. An important task will be, therefore, to clarify to what extent these differences are driving the results. Besides the question whether one or the other conclusion is more convincing, it will be necessary to establish empirically whether side-payments, to the extent they in fact occur in particular geographic and economic settings, can offer effective solutions to transboundary water problems. In a case study on the river Rhine published ten years earlier, Bernauer (1996) found that it took several decades of acrimonious bargaining to set up a side-payment (compensation) scheme in that case. Moreover, this scheme contributed close to nothing in terms of solving the transboundary problem (salination). Given that this solution was implemented by and among rich, democratic, and politically and economically quite strongly integrated countries, Bernauer concluded that there was rather little hope that side-payment strategies would work better in less fortunate regions of the world. This claim is supported also by a more recent case examined by Siegfried & Bernauer (2007), the Syr Darya. In that case third party support enabled the riparian countries of that river to establish side-payments more quickly than in the Rhine case. Nonetheless, an in-depth analysis based on quantitative methods shows that the effectiveness of this arrangement has been virtually nil.

Problems of water allocation are becoming increasingly important in view of climatic changes. In this context, Drieschova et al. (2008) study how water flow variability is dealt with in water treaties. They provide descriptive statistics on flow variability rules in 50 treaties signed between 1980 and 2002, concluding that "open-ended governance mechanisms may provide a means for addressing variability while at the same time accommodating the sovereignty and power concerns that are still a corner stone of water negotiations" (Drieschova et al. 2008, 293).

Like Dombrowsky and S. Dinar, Conca, Wu & Mei (2006*a*) examine international water treaties. However, they do not focus on specific institutional design characteristics, but rather on the emergence of fundamental, globally accepted principles of international water law (such as basin-wide participation in agreements, equitable use, territorial integrity and sovereign equality, avoiding significant harm, information exchange and consultation, and peaceful dispute resolution). Using information from the TFDD and FAOLEX databases they code the contents of 62 international treaties from 1980 to 2000. Conca et al. show that some principles

emanating from global efforts have experienced growth, diffusion, and deepening at the river basin level, notably principles of environmental protection, consultation, and peaceful dispute resolution. And yet, the rate of growth of international water agreements has been very modest in the 1990–2000 period, with most new agreements concluded in basins where there was already a history of cooperation. Few agreements include all riparian countries, and several important principles (e.g. the principle of avoiding significant harm) show no significant signs of deepening and diffusion. The authors observe, moreover, that convergence on two partly conflicting normative frameworks has taken place, one emphasizing joint protection/management of transboundary rivers, the other emphasizing countries' national rights. By and large, Conca, Wu, and Mei conclude that there is only weak evidence for the emergence of a "global rivers regime." Their important achievement is that their work links developments at the global to the regional level and that it offers a more nuanced view on the evolution of international freshwater cooperation than studies focusing merely on water treaties as a binary dependent variable.

A book by Conca, published in 2006, operates very much along the same lines as the journal article just discussed. He describes and explains the evolution of normative principles and practices in transboundary water management. He thus examines processes of institution building by focusing on changes in normative frameworks, the nodes, sites, networks, and platforms in the international systems where such frameworks are debated and developed, and the roles played by state and non-state actors in this realm. With two case studies, on Brazil and South Africa, he also explores how transnational processes are reaching into the domestic sphere.

2.6 Assessing the Effectiveness of International Water Management Efforts

As noted above, most large-N research on international water management focuses on policy-output variables (notably, treaties and events data). This focus is clearly justified, because policy output is usually a necessary condition for problem solving. However, most studies readily agree that these variables tell us rather little about the effectiveness of international efforts in terms of solving specific problems that motivate cooperation. Many qualitative case studies include some assessment of how substantive or effective international cooperation is. But the criteria against which the depth or substance of cooperation is measured differ very much across studies (Bernauer 2002, Dinar & Dinar 2003). Moreover, most assessments rely on non-causal criteria. The most common approach in this respect is to describe, over time, the development of a particular problem targeted by a cooperative effort (e.g. pollution of a river) and to assess compliance with international obligations in this respect. This is usually done without systematic analysis of whether and how changes in the environmental outcome and in compliance levels have, ceteris paribus, been affected by international cooperation.

Substantial progress has been made in recent years with measurement concepts focusing primarily on policy outcomes or problem solving (e.g., environmental behavior, or ecological parameters) rather than policy output (i.e., international agreements and their content). Work by Sprinz & Helm (2000) Sprinz and Helm (2000), Hovi, Sprinz & Underdal (2003*a*,*b*), and Underdal

(1992) on the effectiveness of international environmental regimes is particularly noteworthy in this regard.

Building on this work, Siegfried & Bernauer (2007) have developed a policy performance concept that relies on three parameters: the outcome that should ideally be reached (optimum), the performance of a given policy at the time of measurement (actual performance), and the outcome that would have occurred in the absence of this policy (counterfactual performance). To demonstrate that this measurement concept is empirically useful and can provide policy-relevant insights, the authors examine international water management in the Syr Darya basin, a major international river system in Central Asia. The study focuses on the Toktogul reservoir, the main reservoir in this basin, and its downstream effects. The principal policy challenge in this case has been to design and implement international tradeoffs between water releases for upstream hydropower production in winter and water releases for downstream irrigation in summer. The analysis reveals that the international arrangement in place since 1998 is characterized by high levels of compliance, but low average performance and high variability over time. The principal policy implication is that the management system in place for the Syr Darya is in need of repair. The more generic insight is that improved diagnostic tools that look beyond policy output and compliance can help in identifying management systems for international river basins that rest on "shallow" or unstable cooperation and thus require reforms. Rieckermann et al. (2006) have applied a simpler version of this performance concept to Lake Titicaca.

The advantage of this approach to measuring policy performance is that it forces the analyst to make explicit assumptions (e.g., with respect to optimal performance). In addition, it focuses on causal effects and problem solving, and it produces quantitative assessments that are comparable across cases of river management. The main disadvantages are that some aspects of performance are difficult to quantify, and that carrying out such an assessment is quite labor-intensive. At least for the time being, the method appears more suitable for the analysis of individual river management cases. Large-N studies will probably have to continue relying on events and treaties, as well as on relatively simple types of policy outcome data (e.g., pollution).

2.7 Policy Implications

Existing research on international water management has produced a substantial amount of policy-relevant analytical concepts and empirical findings. For example, events data and methods for assessing policy performance can serve as diagnostic tools for identifying water systems at risk. Moreover, empirical research on water-related conflict has helped in debunking the water wars claim and has thus been instrumental in refocusing policy makers' attention on more relevant challenges to be dealt with.

The literature addressing institutional design issues is heavily dominated by qualitative case studies on individual rivers and comparative case studies guided by a "lessons learned" approach. This makes it difficult to extrapolate from research on past experience to the future, or

from one river management case to others. Dinar et al. (2007, 224) in fact note that "there is no one solution that fits all situations. There is also no clear recommendation on how to build a sustainable regime for a given basin. [...] River basin modeling has shown that there are a wide range of approaches for specifying a model for river basin planning, development, and management."

This caveat notwithstanding, several findings from the existing literature seem to be applicable across a rather wide range of political, economic, social, and geographic contexts.

First, cooperative arrangements are likely to be more successful when they involve strong and competent international river commissions, and if they systematically link such commissions and national level authorities, thereby ensuring financial and political support within riparian country bureaucracies (e.g. Marty 2001).

Second, fairness (equity) is one of the key concerns of all governments when they engage in international water cooperation. Joint investigations into scientific aspects of a problem and possible solutions, as well as joint projects for implementing agreed measures, can mitigate fairness concerns (e.g. Wolf 1997).

Third, political symbols and prestige effects can encourage cooperation. Such strategies can be particularly important where material incentive strategies fail to address concerns over fairness or in cases where countries are generally reluctant to cooperate (e.g. Durth 1996).

Fourth, great efforts should be made to systematically assess the problem and the range of possible solutions before deciding on and implementing policies. Quick fixes in international river management are virtually nonexistent. Successful cooperation evolves over decades rather than years. Additional time spent on fully investigating a problem and evaluating different possibilities for action will usually be compensated for by more effective implementation. Joint data gathering and analysis can help in avoiding data disputes later on, which frequently are a major component of overall water conflict. Most studies note, however, that technological fixes have rarely if ever played a decisive role in solving international river problems (e.g. Dinar et al. 2007).

Fifth, involvement of all principal stakeholders may delay agreement, but tends to prevent breakdowns in the implementation process. Nongovernmental participation may help in removing efficiency-reducing information asymmetries and forcing governments into more efficient cooperation and accountability. It also tends to open up more avenues for transnational (in addition to international) activity that generates innovative solutions (e.g. Durth 1996, Marty 2001).

Sixth, potentially the most controversial conclusion of several studies is that IWRM may look

nice on paper but does usually not produce the desired results. The implication is to avoid complicated package deals (issue linkages) that risk creating a mismatch between tasks and resources, and to focus on clearly defined problems and specific, operational institutional arrangements.

2.8 Online Resources

Dartmouth Flood Observatory. At www.dartmouth.edu/~floods/, accessed June 2, 2009. Satellite data on floods and related issues.

EMDAT: The International Emergency Disasters Database. At www.emdat.be/, accessed June 29, 2009. Occurrence and effects of mass disasters from 1900 to the present, including droughts and floods.

European Environmental Agency: Waterbase – Rivers. At http://dataservice.eea.europa.eu/dataservice/metadetails.asp?id=1081, accessed June 29, 2009. The EEA provides data on water quality and quantity in rivers, lakes, groundwater bodies, and transitional, coastal, and marine waters in Europe, as well as land use data associated with water quality measuring stations.

FAOLEX. At http://faolex.fao.org/waterlex/, accessed January 20, 2008. WATERLEX, part of the FAOLEX database offers information on international agreements on international water sources.

Global Environmental Monitoring System, GEMStat. At www.gemstat.org/queryrgn.aspx, accessed January 20, 2008. Global water pollution data (disaggregated) is available at GEMStat.

Global International Waters Assessment. At www.unep.org/dewa/giwa/, accessed June 2, 2009. GIWA publishes assessment reports on water quality in 66 water areas worldwide.

International Commission on Large Dams (ICOLD). At www.icold-cigb.net/, accessed June 2, 2009. Non-governmental international organization which provides a forum for the exchange of knowledge and experience in dam engineering.

International Water Law Project. At www.internationalwaterlaw.org/, accessed January 20, 2008. International Water Law Project provides documents, such as international agreements, declarations, and resolutions, on international water law and policy issues.

International Water Management Institute of the Consultative Group on International Agricultural Research (CGIAR). At www.iwmi.cgiar.org/, accessed January 20, 2008. IWMI is a research center focusing on the management of water and land use.

Issue Correlates of War (ICOW) Project. At www.paulhensel.org/icow.html, River Claims Data at www.paulhensel.org/Data/rivcode.pdf, accessed June 2, 2009. Data on river claims, collected by Paul R. Hensel and co-authors.

Water and Conflict Bibliography. At http://biblio.pacinst.org/conflict/index.php, accessed December 16, 2007. The Water and Conflict Bibliography is produced and maintained by the Pacific Institute.

Transboundary Freshwater Dispute Database. At www.transboundarywaters.orst.edu/database/, accessed December 7, 2007. Database on river treaties, water events, and basin characteristics, such as population density in basin area. Links to several publications by Aaron Wolf and co-authors.

From Potential Conflict to Co-operation Potential (PCCP). At www.unesco.org/water/wwap/pccp/index.shtml, accessed January 20, 2008. A UNESCO initiative. Case studies on selected river basins.

UNEP Division of Early Warning and Assessment, Assessment on Water. At www.unep.org/dewa/assessments/ecosystems/water, accessed January 20, 2008. Assessment of the world's water resources.

Water Footprint. At www.waterfootprint.org/?page=files/home, accessed January 20, 2008. Figures on the water footprint: "The water footprint is an indicator of water use that looks at both direct and indirect water use of a consumer or producer. The water footprint of an individual, community or business is defined as the total volume of freshwater that is used to produce the goods and services consumed by the individual or community or produced by the business."

World Water Council. At www.worldwatercouncil.org/index.php?id=866, accessed January 20, 2008. International multi-stakeholder platform on water issues.

Chapter 3

Transboundary Waters – A New Event Data Set

Anna Kalbhenn

Abstract:

This paper describes the construction of a new dataset on transboundary river basin cooperation and conflict based on event data derived from local newspapers worldwide. We have coded any reported event related to water quality, joint management and water quantity in international rivers globally for a time span of 11 years and have attached an intensity scale and an assessment of salience to these events. Research on the conditions that facilitate or hinder the successful and sustainable management of transboundary freshwater resources has intensified in recent years. Most of this work has been based on individual qualitative case studies or comparisons of results from a few such case studies. Given that many of these case studies do not generalise to a larger population, large-N quantitative studies may prove useful to complement the findings from small-N work. The main bottleneck to progress in this area is good time-series-cross-section data on international water cooperation and conflict. Large-N research to date has relied almost exclusively on two datasets (ICOW River Claims Dataset, Transboundary Freshwater Disputes Dataset, TFDD). These datasets have been highly useful in prior research and the TFDD is expanded and complemented in several ways by the new dataset described in this paper.

3.1 Introduction

Recent empirical research on transboundary water issues has moved from case study evidence towards large-N quantitative studies (cf. Brochmann & Hensel 2009*b*, Gerlak & Grant 2009, Tir & Ackerman 2009, Stinnett & Tir 2009*a*). Nevertheless, large-N studies on the management of international freshwater resources are still rare, due to the lack of adequate data. This paper introduces a new events dataset on transboundary water events building on and expanding existing large-N datasets. By creating an encompassing dataset on transboundary water events, we close an important gap in the growing research field on the management and conservation of natural resources and also provide a service to other scholars.

Widely used data on transboundary waters includes the Transboundary Freshwater Disputes Database (TFDD, `http://www.transboundarywaters.orst.edu`), Faolex[1] and the ICOW River Claims dataset (`http://garnet.acns.fsu.edu/~phensel/icow.html`).[2] The latter has so far been completed for the Americas, Northern and Western Europe, and the Middle East. It focuses on river claims defined as "evidence of contention involving official representatives of two or more nation-states" (Hensel 2005). Faolex provides information on national and international legislation on freshwater resources (summaries and translation) and offers a useful source for studying institutionalized cooperation. Likewise, Aaron Wolf and his co-authors have build the International Freshwater Treaties Database covering nearly 450 international, freshwater-related agreements, from 1820 to 2007. The same site hosts the Transboundary Freshwater Dispute Database (TFDD) reporting events regarding conflict and cooperation over shared rivers based on a content analysis of different news sources. It features events on "water quality", "joint management" and "water quantity".

The dataset described in this paper primarily aims at extending and complementing existing data-projects. One feature in this respect is that – in contrast to the TFDD – the new dataset provides information on both events and non-events. Currently, it is unclear whether non-events in the TFDD are due to the fact that no water events occurred in a given time period for a certain basin or whether the respective basin-years are (not yet) coded. For example, a simple search for all events concerning the Nile basin provides events up to November 1999. On the database site it is stated that events were documented up to 2005. It is thus unclear whether the last six years were event free or have not yet been coded. Similarly, searching for events within certain basins (e.g. the Buzi basin) provides no results, where it is again unclear whether these basins have not been coded or no events occurred. The new dataset, in turn, provides entries for every basin-country pair-year with a dummy variable indicating whether or not any events occurred. Second, several additional variables are coded. For instance, the TFDD indicates in how far an event is of cooperative or conflictive nature, but does not offer information on how salient it is. The current dataset provides information on salience (taking into account citizens' concern as expressed in the respective press articles), the direction of action, additional information on the information sources (i.e. location and neutrality/ independence) and indicates whether certain events are linked to other events. Third, the TFDD is based on information provided by the Foreign Broadcast Information Service (FBIS). Comparing coding results based on the FBIS and BBC-Monitoring for a random sample of the same rivers and years, I found that BBC-

[1] `http://waterlex.fao.org/waterlex/srv/en/home`, consulted June 10th 2009

[2] For a discussion of reliability of the ICOW data set, the reader is referred to Rothman (2007)

Monitoring offers larger coverage in terms of local newspapers. Hence, the dataset presented here is based on BBC-Monitoring rather than FBIS. In addition, the search algorithm used by the TFDD for selecting press articles to be coded appears not always to detect all relevant events. To give an example, I conducted a reliability check by searching FBIS (the source the TFDD is based on) for events on transboundary water management regarding the Kura-Araks basin, and coded two events for 1998, both of which have been omitted by the TFDD. Given that the TFDD actually covers the Kura-Araks basin until 2004, these two events should appear in the database. Further, I found no relevant event in 1999, whereas the TFDD names an event on Armenia returning occupied territories to Azerbaijan. However, this latter event is not related to cross-border rivers or water interactions at all, which is why it should not feature in the dataset. For almost all basins coded within the scope of a feasibility study for the new dataset relying on national newspaper articles, at least one event per year is missing in the TFDD.

The remainder of this paper is structured as follows: the next section describes the data collection, followed by a discussion on coding issues, section 3.4 presents some descriptive statistics, and the final section concludes.

3.2 Data Collection

The unit of analysis of the new dataset is the basin-dyad-year, where dyad refers to a pair of countries. This has the advantage that events can be traced back to both the basin and the country (or dyadic) scale, allowing for numerous ways of analysing international freshwater issues. In fact, former studies on institutionalised cooperation over shared rivers have shown markedly different results depending on the level of analysis (Hoffman 2003, Espey & Towfique 2004, Gerlak & Grant 2009, Hamner 2009, Tir & Ackerman 2009). Further, this level of aggregation and the connection of the spatial and temporal dimension permit merging the data with many other datasets collected at either the country, dyad, basin, or annual level (or any combination thereof). The dataset covers some 260 river basins from 1997 to 2007.[3]

Information on water interactions is retrieved from local newspapers made accessible through BBC-Monitoring (`http://www.monitor.bbc.co.uk/`). This database provides translations of local media sources from around the world and thus lends itself for extensive content analysis to create event-datasets relying on local news rather than on western press agencies such as Reuters. This is especially helpful in the current context, where events that are of local (or even regional) importance, but do not feature high on the international agenda, are relevant for the topic of study. It thus allows to capture events not reported by major western press agencies and to avoid respective bias. The caveat with respect to the usage of newspaper articles is that they are selective with respect to the events they report on (Franzosi 2004, 167). However, as Franzosi (2004) concedes: "perhaps all data are biased in some ways. What is important is to know the type and form of bias in order to be able to gage its effect on evidence and conclu-

[3] Admittedly, eleven years is a rather short period of time. However, for this time period data is fairly comparable and the data is of reasonably good quality. Extending the period of investigation further back is prohibitively difficult due to the fact that electronic newspaper archives only reach back to the 1990s. This shortcoming could be addressed through case studies covering longer time-periods.

sions" (Franzosi 2004, 172). Accordingly, I introduce a variable indicating the neutrality of the media source, based on whether or not reporting is independent of the government. Data for this variable is coded based on information by FBIS.[4]

The recording-units (Krippendorff 2004a, 99-100) are single newspaper articles, gathered by automatically searching the BBC-Monitoring Database for the following string of keywords:

> BASINNAME AND (pollut* OR contamin* OR toxic waste OR purification OR sewage OR effluence OR scarc* OR shortage OR lack OR insufficiency OR stream OR waterway OR tributary OR canal OR watercourse OR dike OR dyke OR irrigation OR dam* OR diversion OR flood OR draught)

where BASINNAME is substituted by the respective basin's name, e.g. Danube, and *s are wildcards, i.e. "pollut*" will find "pollution", "pollutant", "pollute", "polluting", "polluted". The choice of these keywords is an extension of the list of keywords used for the TFDD (`http://www.transboundarywaters.orst.edu/projects/bar/BAR_chapter2.htm`). The reason for choosing these water-related terms rather than keywords more tightly linked to cooperation and conflict is that the former have shown to yield more efficient search results. In particular, including Yoffe and Larson's (2002) cooperation and conflict terms evokes many irrelevant hits. Once these irrelevant hits are eliminated, the resulting search results are equal to those obtained without the inclusion of the cooperation and conflict terms. For the sake of efficiency, I decided not to include these in the first place. Contrary to Yoffe and Larson (2002), I explicitly search for events in certain basins by including the basin's name. The reason for this is twofold. First, separately searching for each basin facilitates the management of search results for subsequent coding. Second, most search engines only allow for a certain number of hits so that a global search for all basins at a time is not feasible. In order to capture all events, despite possibly misspelled basin names, I included the term "river" (many rivers are called river X, e.g. Black Dragon River, River Fly and often articles at some point refer to the water course using the word river). I double-check the inclusion of all basins by constraining my search to single countries and entering the following keywords in the BBC-Monitoring search engine:

> (water OR stream OR river OR waterway OR tributary OR canal OR watercourse OR watershed OR lake OR channel OR reservoir) AND (pollut* OR contamin* OR toxic waste OR purification OR sewage OR effluence OR scarc* OR shortage OR lack OR insufficiency OR dike OR dyke OR irrigation OR dam* OR diversion OR flood OR draught) NOT (BASINNAMES)

where BASINNAMES contains the list of all basins that were searched for in the first round. The second set of keywords also guarantees that I capture any freshwater related events that are not linked to a specific basin. The disaggregation of such events to the basin level usually follows straight forwardly from the type of event; e.g. if two countries sign an agreement on maximum permissible pollution levels, the scope of this agreement can easily be retrieved from the original text (in fact, many agreements hold for all basins the countries share).

[4] `http://wnc.dialog.com/`

The automatic search based on pre-defined keywords, enhances the reliability in terms of case selection, which, for instance Rothman (2007) emphasizes as an aspect of data reliability often neglected in international relations datasets.

I conduct full text searches, as simply searching titles can be very misleading, because sometimes press review articles contain important information on relevant events, their title reading something similar to "Bulgarian news agency review of Bulgaria press for 5 Nov 99". Albeit being very well covered by the media, many relevant articles on for instance the Danube would be omitted by a simple title search. This is due to the fact that newspaper headings often do not fully reveal what the respective article is about. Continuing with the above example, one article by the MTI news agency in Budapest on the Danube dam row in 1999 is titled "New Slovak envoy to Hungary wants to strengthen friendship" (MTI news agency Budapest, June 14th 1999).

The articles obtained by searching BBC-Monitoring as described above were first scanned in order to find out whether they contain information on relevant events. In a second step, the events were coded according to the rules specified in the next section.

3.3 Coding

Choosing newspaper articles rather than newswire reports as recording units has an important implication for the coding of these texts. Due to journalistic jargon, newspaper articles use a special type of language. This is why I decided to rely on human coding, although automated coding is becoming more and more popular in the social sciences (e.g. Kovar 2000, Schrodt 2000). The automated analysis of newspaper articles in a way that captures the semantic context imposes high requirements to coding software, because newspaper articles vary largely in length, style of writing, and vocabulary (Wüst 2007, 9). So far, there is no coding software designed for this type of text-input. Commonly used software, such as KEDS and the VRA-Reader are optimized for Reuters' lead paragraphs. These parsers are not capable of deciphering the semantic context of complex texts found in newspaper articles (Wüst 2007, 15). Other routines, such as Relation Mining manage different types of text-input, but are constrained in the topics they are capable of coding correctly. Relation Mining was originally designed to find semantic relationships between genes and proteins in academic journal articles in molecular biology (Wüst 2007, 6). These types of articles are more stringent in their sentence structure and the usage of key terms than common press articles (Wüst 2007, 9). Apart from its labour-intensity, the main caveat of human coding is its subjectivity. In order to obtain maximum objective coding, I have established standardised coding rules and extensively trained all coding assistants to guarantee that these rules were well understood. In addition, I periodically checked whether data collection and processing were consistent with the coding. Further, several control variables allow for tracing potential coding errors. As such, I use both a string code and a numeric code for basins, countries, and types of events. The data generation and data management process does not only follow a standardised procedure, it is also documented in a consistent manner. Any problems regarding how to code certain events are documented in a traceable way in order

to guarantee replicability. To allow for maximum transparency, the variables *date* and *source* can be used to identify each press article. In case of doubts on the accuracy of certain codings, these can thus easily be cross-checked. Finally, I had each coding assistant re-code a subsamble of basin-years, previously coded by a different assistant, using the same coding instructions (Hodson 1999, 29). Whereas different coders mostly agree on cooperation levels, the direction of action, the issue dealt with and whether or not an interaction constitutes a new event or is tied to former interactions, there are often diverging codings for salience. Details are presented in the appendix.

The coding process itself requires the coding of the following 19 variables: *country, ccode, acr, basin, basinno, basinacr, year, date, issue, issueno, event, bar, descr, direction, salience, source, sourceloc, neusour,* and *case*. *Country, ccode,* and *acr* are coded for each of the countries involved in a certain event, referring to the name of the country (string), its cowcode and its cowacronym.[5] I use cowcodes and cowacronyms as unique identifiers, since many third party country- or dyad-level data rely on these codes. Similarly, *basin* is the name of the basin in question, *basinno* and *basinacr* are a unique number and acronym assigned to each basin. Basin numbers and acronyms are obtained from PRIO's shared rivers dataset available at `http://new.prio.no/CSCW-Datasets/Geographical-and-Resource-Datasets-/Shared-rivers/`. Using these predefined codes facilitates merging third party data.

I include the *year* an event occurs to facilitate the usage of the data at different levels of analysis (country-year, dyad-year, basin-year). Disaggregating the data to monthly, weekly or even daily events makes little sense, because most other covariates (economic indicators, population figures, etc.) are only available on a yearly basis, in fact most IR-data is constrained to country-years. The variable *date*, indicating the specific day an event was reported on, is merely included to keep track of the press articles that were coded in cases of doubts on coding accuracy. *Issue* and *issueno* classify events to *water quality*, *water quantity*, and *joint management*. Water quality refers to any action concerning pollution levels, water quantity captures any events concerned with water scarcity, and joint management are actions that alter the flow of a river, such as the construction of a dam. The distinction of different issue areas facilitates more specific analyses on any of these subtopics. One might argue that the determinants of potential conflicts over water pollution are not the same as those on water scarcity. The issue variable allows to empirically account for such differentiated theoretical arguments by splitting the analysis into issue-specific subsamples. *Issueno* assigns a number to each of these three categories, whereas *issue* is a string variable (reading "water quality", "water quantity", or "joint management"). This redundancy facilitates checks for possible coding mistakes. During a feasibility assessment, one coder consistently coded issueno 3 instead of 1 and vice versa; this error was easily detected and removed by crosschecking with the string variable *issue*.

Event is a short description of the event, such as "Turkish prime minister visits Bulgaria, proposal on dam in Arda river" or "letter of Bulgarian environment minister to Serbian counterpart proposing joint expert group on waste water discharge". This description is included for reasons of traceability. Tightly linked to the event description is the variable *bar*, assigning the level of cooperation or conflict to each event. It is coded in integers ranging from -6 to +6.

[5] `http://www.correlatesofwar.org/`

The meaning of each of these thirteen categories is sketched in table 3.3. The bar-categories rely on, but differ quite considerably from those of the TFDD (Yoffe and Larson 2002). The TFDD bar scale is based on the COPDAB scale of cooperation and conflict and ranges from -7 (formal declaration of war) to 7 (voluntary unification into one nation). Given that both -7 and 7 are never observed empirically when it comes to water events, I have left out these categories. Further, I adapted all other categories to be more specific to the context of transboundary waters rather than based on military terms. For instance, a bar scale of 5 in the TFDD refers to military, economic or strategic support, such as "selling nuclear power plants or materials" (`http://www.transboundarywaters.orst.edu/database/event_bar_scale.html`). In the new dataset, a bar of 5 refers to official support, such as "signing of freshwater treaty". *Descr* is a variable intended for the purpose of avoiding coding mistakes. Whereas *event* is a short description of the specific event, *descr* is a verbal statement of the class of event, such as "signing of freshwater treaty" (bar 5) or "meeting of high officials discussing joint water issues" (bar 1). These descriptions coincide with those used for describing the bar categories.

The nominal variable *direction* shows whether cooperation is mutual or unidirectional. If country one initiates the event, direction takes the value 1, if country two does so, direction takes the value 2, and if the event is one of mutual action, direction is coded 3.

Current datasets do not allow the assessment of the salience of environmental problems in transboundary rivers. I capture the *salience* of water issues by coding the degree of citizens' concern as expressed in press articles.[6] I only distinguish three levels of salience, because more categories would probably introduce unreliable coding. The reliability of this measure is also questionable if the press in the respective country is not free. Accordingly, I cross-check with the reports of the other country in the respective dyad. Further, the dummy variable *neusour* indicates the independence/ neutrality of the source newspaper from the government. This variable allows to control for the neutrality of the sources when analysing the data and could help in assessing whether, for instance autocracies overreport cooperative events. *Source* and *sourceloc* refer to the name and the location of the source used to code the event. These two variables are mainly aimed at increasing transparency by allowing to trace the original text of all coded events.

Finally, *case* assigns a unique number to each case. That is, the first observation is coded 1, for each subsequent observation case is increased by one if this observation constitutes a different event and stays the same if it concerns the same event. This variable helps assess whether governments really cooperate on many different issues or merely re-negotiate the same problem over and over again. For instance, if India and Pakistan discussed the same hydro-power project on the Indus over and over again, *case* would assume the same integer value for all related events. In turn, the Egyptian government promising flood relief aid to Sudan and the Ethiopian water resources minister announcing a coordinating office of Egypt, Ethiopia and Sudan to facilitate the construction of 13 power generating dams and an irrigation development project are considered different events and thus have different values on the *case* variable.

[6] I rely on citizen's concern rather than the number of events reported for a basin to proxy salience, since the latter probably reflects media coverage rather than salience.

Table 3.1: *Number of riparians*

# riparians	Freq.	Percent	Cum.
2	175	67.31	67.31
3	46	17.69	85.00
4	20	7.69	92.69
5	6	2.31	95.00
6	4	1.54	96.54
8	3	1.15	97.69
9	2	0.77	98.46
11	2	0.77	99.23
13	1	0.38	99.62
18	1	0.38	100.00
Total	260	100.00	

3.4 Descriptive Statistics

The current dataset reports events in some 260 transboundary river basins. As shown in table 3.1 most of these basins are shared by two countries, some by 3 or 4 and only very few by 5 or more countries. The basin with the highest number of riparians is the Danube with 18 riparians. It is therefore hardly surprising that disproportionally many events (26% of all events) take place in the Danube basin. The high number of riparian countries implies that for instance a meeting of the Danube commission attended by all riparians gives raise to 153 dyadic events. Depending on the context, such cases (similarly, almost 14% of all events take place on the Nile) might thus be weighted accordingly or considered separately when using the data for inferential statistics.

In terms of country pairs exhibiting notably many events, Hungary and Slovakia constitute more than 2.6% of all events, all of those located on the Danube. Most of these events refer to a lengthy dam dispute between the two countries that gave raise to several interactions. Once the data is aggregated as described below, the two countries do not exhibited significantly more interactions than other country pairs. Also Hungary and Romania have many common events on the Danube (roughly 2% of all recorded events). In this case, many of these are related to a cyanide spill caused by Romania. Romania and the Ukraine had a lenghty dispute (accounting for about 2.5% of all events), because of Ukrainian plans to construct a canal unwanted by Romania. Apart from these interactions on the Danube, Russia and China have more common events than other dyads (about 2% of all events) related to the Amur and Tumen basins.

It should be noted in this context that the dataset is comprised of undirected dyads. That is, an event between two countries only enters the dataset once. The data is arranged in a way that the first country code is always the smaller of the two to facilitate merging the data with other dyadic datasets. Nevertheless, the variable *direction*, indicating which country (if any) was the initiator of the event, allows for directed analyses. Of all reported events, almost 36% are directed, the remaining 64% are mutual events, such as joint conferences.

As mentioned above, some events actually concern the same issue, but are split into several interactions, because governments re-nogotiate the same topic or have several follow-up meetings, etc. When presenting descriptive statistics on the data, I first present statistics on the event-level, regardless of whether or not these events are independent. I then aggregate the events by taking

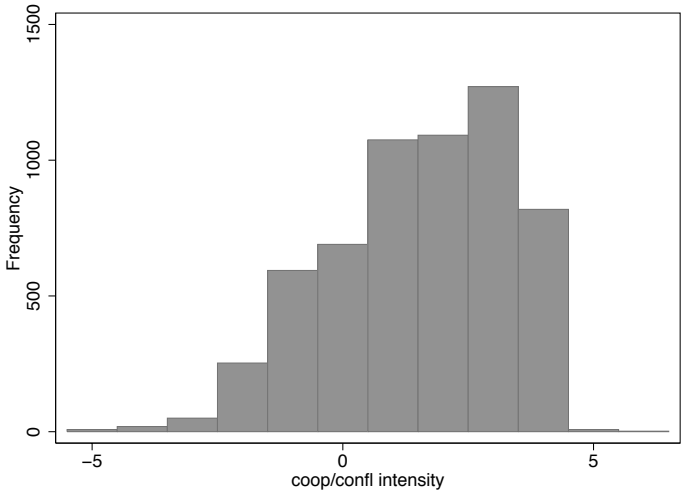

Figure 3.1: *Overall distribution of Cooperation and Conflict Intensities*

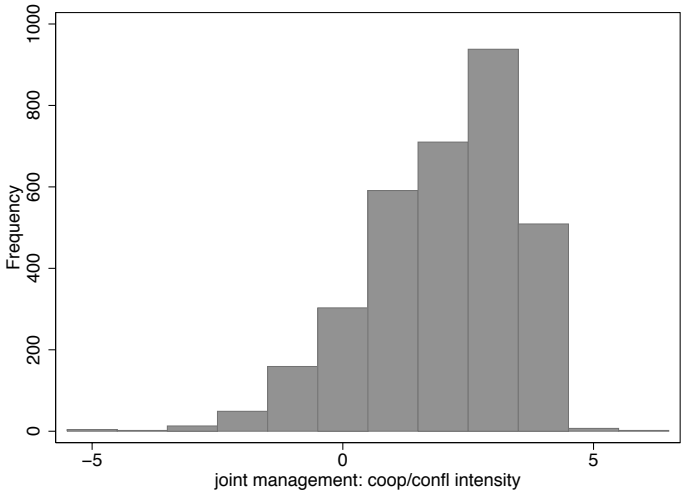

Figure 3.2: *Distribution of Cooperation and Conflict Intensities: Joint Management*

the median value of the intensity score in case of several interactions concerning the same issue (e.g. India and Pakistan discussing the same hydro-power project on the Indus over and over again).

Further, when presenting distributions, I distinguish between only taking into consideration events and including "non-events", i.e. basin-dyad-years in which no event occurs with the conflict/cooperation intensity score being coded 0. In order to present "non-events", I have merged the events data to all potential basin-dyads worldwide; data on the latter is adopted from Owen et al. (2004).[7] The authors include all river sharing dyads from 1816 to 2002, including both contiguous and non-contiguous countries. The data structure can easily be extended to 2007 given that – according to the Correlates of War (2008) "System Membership Data" – apart from Montenegro's independence in 2006, there are no changes to the international systems

[7] We have cross checked the validity of the data and adjusted it for certain inaccuracies.

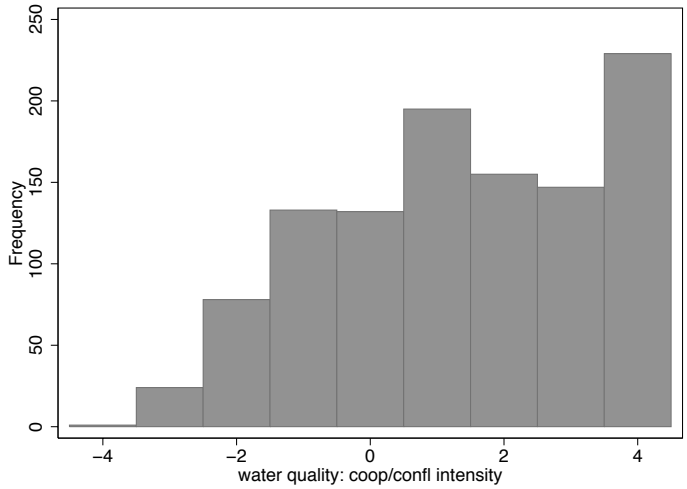

Figure 3.3: *Distribution of Cooperation and Conflict Intensities: Water Quality*

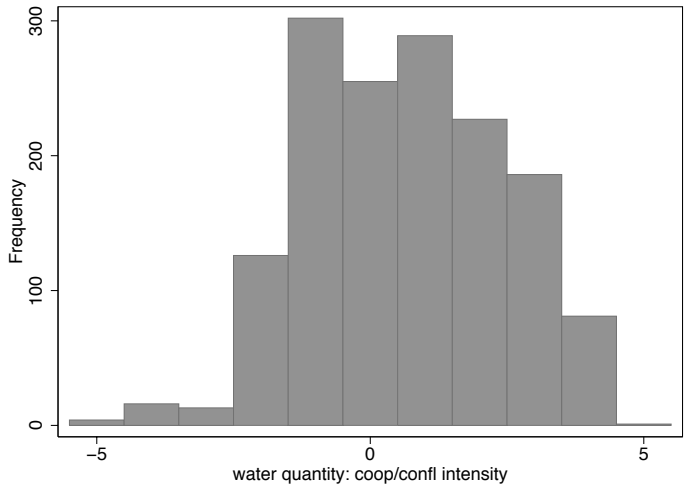

Figure 3.4: *Distribution of Cooperation and Conflict Intensities: Water Quantity*

that invoke any changes concerning which countries share what river. I have manually adapted the data to incorporate Montenegro's independence. Rather than including all dyads in the international system, the dataset thus only includes those that actually share a river. However, certain instances in which a former riparian (i.e. Russia with former Sowjet countries) interacts with current riparians are maintained in the dataset. In these cases, the variable *ev* assumes the value 1. If wished so, these events can thus be easily removed for analyses.

Considering all basin-dyad-years, in more than one third of these some events happen. Slightly more than half of these are on joint management; water quantity and water quality constitute 19 and 26% of all events.

As to the distribution of conflict and cooperation intensities, figures 3.1 to 3.4 show the overall

distribution, as well as the distribution for the three sub-issues (joint managment, water quality, and water quantity) on the event level. Figures 3.1 and 3.2 are very similar, since most observations concern joint management.

A cursory look at these figures reveals that rather few extreme events are reported (2 events score 6, 8 score -5). Whereas events concerning joint management span almost the entire range of possible intensity scores, events on water quality only range from -4 to +4. An example for one of the most conflictive events reported (i.e. -5, since no events with a conflict intensity of -6 were reported for the period of analysis) is " A Romanian border guard boat forces a Ukrainian cruise ship off course, aiming Romanian guns at the passengers", which took place between Romania and the Ukraine in October 2004. Interestingly, one of the most cooperative events happened earlier that year between the same two countries: "Romania approves draft law on ratification of Romanian-Ukrainian treaty on state borders and mutual assistance" (providing for a joint border commission to check the river border line). The other +6 event concerns Kyrgyzstan and Kazakhstan ratifying an agreement regulating the joint use of the water facilities on the Chu and Talas rivers in May 2001.

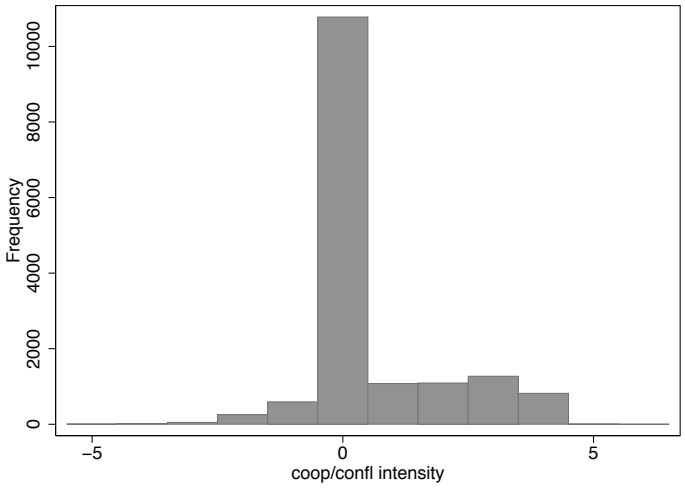

Figure 3.5: *Distribution of Cooperation and Conflict Intensities, including non-events*

Figure 3.5 shows the distribution of conflict and cooperation including "non-events", i.e. basin-dyad-years in which no events are reported and where the intensity score is consequently set to zero. I have created an additional variable *nev* assuming the value 1 if no event occurred and 0 otherwise to allow for the distinction of zero intensity values due to no interaction and those due to neutral interactions, such as rhetorical statements. Examples for such rhetorical statement are "Iran's Director of Ports and Shipping Organization states deepening and widening the Volga Canal by Russia will make the waterway suitable for international traffic", "both parties (Germany & Poland) said that the regulation of the Oder must be tackled in a trilateral effort, together with the Czech Republic", or "Bulgarian president Purvanov expresses sympathy with flood victims in Austria, Germany, Czech Republic".

Finally, figures 3.6 and 3.7 show the distribution of cooperation and conflict intensities for aggregated events - both ex- and including non-events.

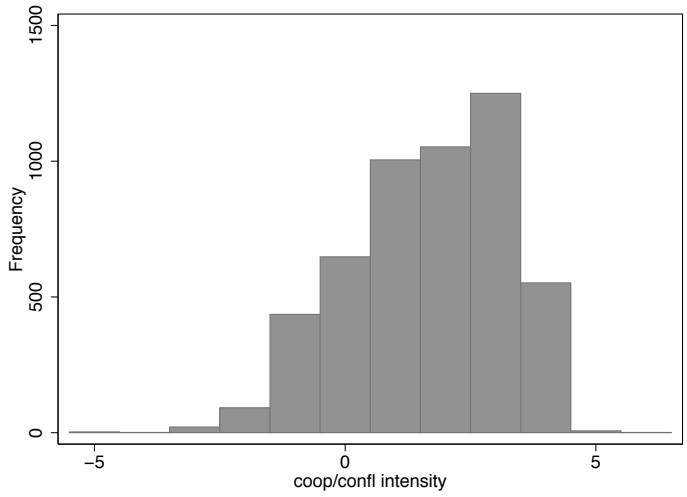

Figure 3.6: *Aggregated distribution of Cooperation and Conflict Intensities*

In terms of salience, more than three quarters of all events exhibit low levels of salience, and only three percent are coded as very salient. The high number of events with low salience is partly driven by events on joint management of which roughly 80% have low salience. Both in case of water quality and quantity, only about 70% of the events have low salience and more than 20 % have a medium level of salience. The distribution is similar when aggregating interactions.

3.5 Conclusion

Recent research on transboundary water issues has moved towards large-N quantitative studies (cf. Brochmann & Hensel 2009*b*, Gerlak & Grant 2009, Tir & Ackerman 2009, Stinnett & Tir 2009*a*) to complement the findings from small-N work. It is obvious, however, that the main bottleneck to progress along these lines is good time-series-cross-section data on international water cooperation and conflict. This paper introduces a new events dataset on transboundary water events building on and expanding existing large-N datasets, such as the TFDD. Comparing the new dataset to previous events datasets shows that the data collection and coding captures many relevant events that are not included in the TFDD. Further, I have added several variables that allow for more nuanced analyses (e.g. the salience of events and their connectedness).

Descriptive statistics confirm the common perception (cf. Wolf 1998, Stucki 2005) that cooperative events outweigh conflicts over shared water resources. Nevertheless, there is considerable variation in the conflict and cooperation intensities of recorded events. Whereas more events are reported on certain large basins, there appears to be no bias in terms of certain country-pairs having more interactions over their shared rivers than others. Nor is there a time trend in the

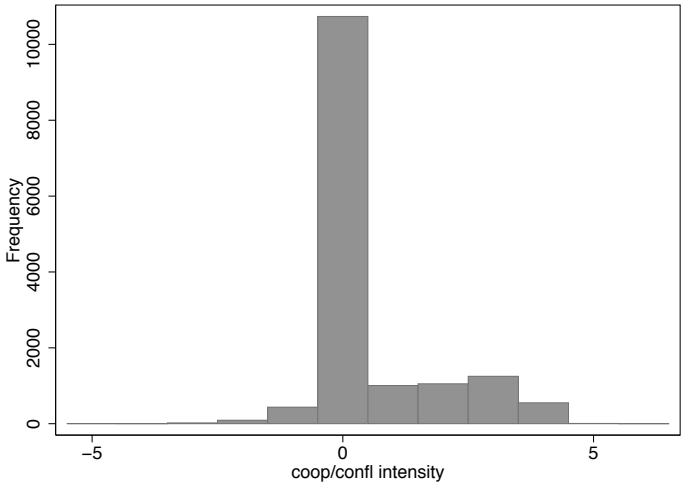

Figure 3.7: *Aggregated distribution of Cooperation and Conflict Intensities, including non-events*

sense of observing considerably more (both in terms of quantity and quality) events in certain time periods than others.

Whereas this paper is limited to a detailed description of the new events dataset, a related paper by Kalbhenn (2009*a*) uses the cooperation and conflict intensities as the dependent variable in a study on cooperation over shared resources. The scientific study of conditions that facilitate or hinder the successful and sustainable management of transboundary freshwater resources has received growing attention in the social sciences community in recent years. The new dataset provides an additional resource to test the empirical implications of prior theoretical work or extend studies of single cases to a larger sample. From a practical policy viewpoint, the most direct utility might be so-called “risk-profiling”. By systematically measuring levels of cooperation and conflict in international river basins worldwide, we will be able to understand better in which river basins we face the greatest challenges in international water management.

3.6 Appendix

Table 3.2 shows intercoder reliability measured by Krippendorff's alpha (Krippendorff 2004*a*). I have used the ordinal version of Krippendorff's alpha and considered missing values (Hayes & Krippendorff 2007).

Table 3.2: *Krippendorff's alpha*

Nile 1997 - 2002, two coders

Variable	alpha	95% confidence interval	
confl/coop	.731	.684	.777
salience	.000		.224
direction	.637	.543	.724
issue	.799	.717	.882
case	.810	.773	.845

Nile 2003 - 2007, three coders

Variable	alpha	95% confidence interval	
confl/coop	.531	.503	.557
salience	.000		.055
direction	.950	.936	.963
issue	.410	.339	.479
case	.935	.927	.942

Ideally, the estimate should be based on a randomly selected sample of recoded cases. Unfortunately, this is not feasible for several reasons. Part of the coding routine is the selection of those articles that need to be coded. The recording-units are thus not defined a priori. Alternatively, I therefore had randomly selected basin-years recoded. However, the random selection resulted in many basins with only very few events so that a systematic assessment of intercoder reliability was not possible. It did, nevertheless, serve to gain a more qualitative impression of intercoder reliability and those variables that appear to be more "difficult" to code than others. In order to estimate a reliability measure, I finally chose the Nile basin to be recoded, since this is one of the basins for which most events are reported. As shown in table 3.2, there is more congruence when considering only two rather than three different coders. Whereas different coders mostly agree on cooperation levels, the direction of action, the issue dealt with and whether or not an interaction constitutes a new event or is tied to former interactions, there are often diverging codings for salience. This variable should therefore be used with caution.

Table 3.3: *Coding of Conflict/ Cooperation*

(*see end of document*)

Chapter 4

A River Runs Through It

Democracy, International Interlinkages and Cooperation over Shared Resources

Anna Kalbhenn

Abstract:

The aim of this paper is to empirically analyse the context dependency of Kantian peace arguments. In particular, I highlight the impact of democratic structures and countries' interlinkages on cooperation and conflict over shared resources. on such resources, as long as the costs of cooperation are outweighed by their supporters loyalty. Further, by weakening asymmetries, facilitating (implicit) side-payments and issue linkage, both economic and political interlinkages may foster cooperation over shared resources. Empirically, I focus on governments' behaviour regarding transboundary river management using a new dataset on transboundary water events covering all international basins for a period of eleven years (1997-2007). Based on these event data, I analyse the effect of democracy, political and economic interlinkages on conflictive versus cooperative behaviour. Additionally, I assess how far government actions with respect to joint river management are driven by the severity and salience of transboundary water issues and consider other context specific factors, such as river geography.

4.1 Introduction

The aim of this paper is to shed light on the context dependency of the allegedly pacifying effects of democracy, political- and economic interlinkages (the Kantian[1] triangle). Whereas some authors note the context dependency of the determinants of intergovernmental cooperation (cf. Russett 1994, 28), there are few empirical studies that explicitly take into consideration under which circumstances democracy, political- and economic interlinkages lead to more intergovernmental cooperation. In this paper, I focus on intergovernmental cooperation over shared resources, the latter bearing the potential for both cooperation and conflict. Rather than simply relying on standard liberal theories (emphasising the pacifying effect of democracy and interlinkages), I develop a theoretical argument highlighting the different circumstances under which democracy and interlinkages might have a cooperation-enhancing effect. In particular, I consider context dependency in terms of asymmetries (geography), citizens' concern and affectedness (problem characteristics) and the cost of cooperation (economic considerations). Democratic leaders' willingness to cooperate might, for instance, depend on the cost of cooperation. I thus argue that democratic[2] leaders have an incentive to cooperate over shared resources as long as the costs of cooperation (e.g. abatement costs) are outweighed by supporters' loyalty. Whereas both political and economic integration are expected to foster intergovernmental cooperation, their effect is expected to differ depending on power and interest asymmetries (geography). Further, certain problem characteristics, such as salience (citizens' affectedness) and severity (cost of cooperation) are expected to have a different impact on cooperation, given different levels of democracy. By differentiating between such dissimilar geographic contexts and incentive structures, this paper aims to provide a more encompassing picture of the circumstances of intergovernmental cooperation.

The empirical focus of this paper is on governments' actions regarding cooperation over shared resources, in particular transboundary freshwater management. Given that many resources are not confined to the national territory, and, likewise many pollutants are transported across national boundaries, governments depend on cooperating with their neighbours in order to provide public goods (Bergin et al. 2005, 28), avoid public bads, or overcome externalities. I rely on freshwater rather than on transboundary air pollution, since rivers are shared by a "small and well-defined group of countries" (Sigman 2003, 01), whereas the origin of transboundary air pollutants is often diffuse. In addition, transboundary rivers particularly lend themselves to study different contexts of intergovernmental cooperation, since they display various power and interest constellations (upstream-downstream scenarios versus border-demarcating rivers). Furthermore, some countries share several rivers with the same neighbour, or "different rivers with different neighbors, giving rise to cross-sectional variation even within countries" (Sigman 2003, 01) and some rivers are shared by multiple countries. When considering different contexts given by river geography, we can thus hold country characteristics constant. Similarly, we

[1] The gist of the Kantian peace argument is that democracies do not fight each other. Extensions of the argument include liberal explanations in more general terms, emphasising the pacifying effects of democracy, economic interdependence and international organisations (cf Russett & Oneal 2001).

[2] When referring to democratic leaders, or democracy as such, the latter is understood as a multi-dimensional concept, characterised by certain institutional features and political rights. I argue that several dimensions of democracy have a non-neglegible impact on democratic leaders' decision whether or not to cooperate over shared resources, but act through different channels. The corresponding conceptualisations of democracy are given below, alongside with the respective theoretical argument.

can study the effect of certain country characteristics (or, in fact, country pair characteristics, such as the joint membership in international organisations) given certain river characteristics. Finally, we can consider different interest constellations within the same pair of riparians in different rivers.

In recent years, various large-N empirical studies on transboundary freshwater issues have been published. Many of these focus on potential conflict between river-sharing countries over either the shared water resource or the borders it constitutes (cf. Toset et al. 2000, Stroh 2004, Furlong et al. 2006, Gizelis et al. 2007, Gleditsch et al. 2006). Whereas these studies provide relevant and important insights on the risk for militarised conflict between river-sharing countries, they neglect whether water-related issues are actually at the core of such conflicts between river-sharing countries. In an effort to disentangle river-related from other types of conflict, the Issue Correlates of War Project (ICOW)[3] is coding events data on official interaction between countries that express claims on cross-border rivers, such as demanding "the right to navigate along the river (typically for purposes of commerce or travel)" (Hensel 2005, 02). Analysing these data, Hensel et al. (2006) and Brochmann & Hensel (2009*b*) find that river institutions help solving ongoing river claims and that the likelihood of successful negotiations over ongoing river claims increases with greater water demands and closer overall relations between riparian countries. Further, Hensel et al. (2008, 132) conclude that "Peaceful and militarised means for managing contentious issues are substitutable and driven by similar processes".

In terms of cooperation on shared resources, several scholars posit that despite "clear epistemic consensus in academia in favour of the 'water Peace' hypothesis" (Stucki 2005, 05),[4] there is still little systematic empirical research on the circumstantialities of cooperative behaviour over shared rivers. Some early studies on transboundary water issues treat cooperation mainly as the opposite of conflict (cf. Brochmann & Gleditsch 2006b); others focus on institutionalised cooperation over rivers, i.e. river treaties (cf. Conca et al. 2006*b*, Hamner 2009, Gerlak & Grant 2009, Tir & Ackerman 2009, Stinnett & Tir 2009*a*). Regarding the latter, we can distinguish efforts to explain why formal cooperation over shared rivers comes about and studies on specific aspects of such institutionalised cooperation. Hamner (2009) finds evidence for the hypothesis that states are more likely to enter into water treaties during times of water stress. In particular, bilateral treaties are more likely to come into being "during a drought shared by both signatory states" (Hamner 2009, 01). Tir & Ackerman (2009), too, examine under what conditions riparian countries enter into treaties dealing with water quantity and quality, highlighting the importance of neo-liberal explanatory factors such as riparians' trade relationships, trade interdependencies and joint democracy. A recent study by Zawahri (2009) analyses the effect of third party mediation on resolving river disputes and establishing stable institutional frameworks. Her case study of the river Indus shows that third party mediators play an important role in monitoring and coordination.

Based on a sample of 118 bilateral water treaties from 1944 to 1998 in 157 international river

[3] `http://garnet.acns.fsu.edu/~phensel/icow.html`

[4] Other critics of the 'water war' hypothesis (stating that rising population density and thus increasing water demands and limited water resources will ultimately lead to war (cf. Starr 1991)) include Wolf (1998) and Dinar (2009*b*).

basins, Espey & Towfique (2004), in turn, find that the most important driving factors of bilateral water treaties are basin- rather than country-specific covariates such as the share of a country's territory covered by a river basin. Country- and dyad-specific characteristics appear to have smaller effects on the probability of treaty formation. Hoffman (2003) considers both basin- and country-specific explanatory variables to analyse which countries form river treaties in which basins. She finds that "basins with treaties tend to be larger, have more riparians sharing the water, and be located at least partially on an international border" (Hoffman 2003, 20). These results are similar to those by Gerlak & Grant (2009), who analyse which factors explain the emergence of cooperative institutional arrangements for river cooperation, considering 63 institutional arrangements in 245 international river basins between 1975 and 2000. The authors' main finding is that institutional arrangements are more likely to be established over basins shared by multiple countries (more than two), and between predominantly democratic riparians with asymmetrical military capabilities (Gerlak & Grant 2009, 29). The depth of institutional arrangement is best explained by existing formalised organisational structures and high economic capabilities.

Going beyond the mere question of when and why water treaties come about, Stinnett & Tir (2009*a*) focus their attention on the degree of institutionalisation of river treaties, and Zawahri & Mitchell (2008) explore when and why riparians choose bilateral over multilateral treaties. They compare "three contexts for cooperation: 1) bilateral river treaties on bilateral river basins, 2) bilateral river treaties on multilateral river basins, and 3) multilateral river treaties on multilateral river basins" (Zawahri & Mitchell 2008, 02). They argue (and find empirical evidence) that the chosen treaty type depends on state interests (e.g. dependency on a particular river), transaction costs, and balance of power. Stinnett & Tir (2009*a*) argue that certain river issues are rather complex, which is why potential member states value more institutionalised treaties.[5]

In this paper, I contribute to the existing literature in several ways. First, I test the applicability of Kantian peace arguments to cooperation over shared resources and emphasise their context dependency distinguishing asymmetries (geography), citizens' concern/affectedness (salience) and the cost of cooperation. Second, I understand cooperation over shared resources as including both formal agreements (such as river treaties) and non-institutionalised forms of cooperation, such as meetings between environmental ministers to initiate or foster joint management of shared basins. This conceptualisation of conflict and cooperation allows for a more encompassing test of the applicability of the Kantian triangle to cooperation over shared resources.[6] Apart from pioneering papers by Wolf (1998), and Wolf, Stahl & Macomber (2003), Wolf, Yoffe & Giordano (2003), existing studies on non-institutionalised forms of cooperation rely mainly on case study evidence (cf. Stucki 2005). Case studies can help us to form educated expectations on when and why transboundary river management is possible and successful, but case studies alone may not suffice to support such considerations with generalisable empirical evidence. Relying on event data on shared rivers, Wolf (1998), Wolf, Stahl & Macomber (2003), and Wolf, Yoffe & Giordano (2003) were among the first authors to show that there is more cooperation than conflict among river-sharing countries.

5 A more extensive overview of this and related literature can be found in Bernauer & Kalbhenn (2009).

6 Both Tir & Ackerman (2009) and Bernauer & Kuhn (2009) rely on Kantian arguments. Their dependent variables (river treaties, water pollution), however, differ from the one applied in this study.

Third, in an effort to expand and complement existing datasets on transboundary freshwater issues, I compile a new events data set. In particular, I examine cooperative and conflictive events between riparian countries' governments with respect to shared international basins.[7] Currently, two datasets are widely used in work on international water cooperation and conflict, namely the ICOW River Claims dataset (`http://garnet.acns.fsu.edu/~phensel/icow.html`) and the Transboundary Freshwater Disputes Database (`http://www.transboundarywaters.orst.edu`). The ICOW River Claims dataset focuses on river claims exclusively, and has so far been completed for the Americas, Northern and Western Europe, and the Middle East. The Transboundary Freshwater Dispute Database (TFDD) reports events regarding conflict and cooperation over shared rivers based on a content analysis of different news sources. It features three variables relevant for the study of cooperative management of international freshwater resources, namely events on "water quality", "joint management" and "water quantity". In building the new dataset, I rely on the TFDD approach, adapting the coding scheme to tailor it to water-related issues and extending the dataset by including more recent events, additional news sources, and some additional variables.

Fourth, my empirical analysis is conducted at the basin-dyad-year level, where dyad refers to a pair of countries. This structure allows me to test for context dependency in several ways, since basin-, country-, and dyad-specific effects may be varied both across and within samples. Existing studies often either aggregate the data to the dyad-, basin, or country level. As such, Tir & Ackerman (2009)'s study on river treaty formation has the dyad-year rather than the basin-dyad-year as the unit of analysis. Whereas the study by Tir and Ackerman allows inference on country- or dyad-specific factors explaining treaty formation, their design does not allow for any conclusion as to whether specific basins (such as those densely populated, afflicted by droughts, highly polluted, etc.) are more prone to be the subject of bilateral treaties than others. Gerlak & Grant (2009), in turn, focus on the basin level, implicitly defining a basin as the aggregate of riparian countries. Certain basin-specific effects might thus only partially reflect the situation in the basin in question (e.g. using water pollution data of all riparian countries as a proxy for pollution in a specific basin, rests on the implicit assumption that country-level water pollution is uniformly distributed across rivers). Hoffman (2003) conducts two separate analyses, one on the country level (considering only country specific effects), the other on the basin level (considering basin-level effects). This approach, however, ignores that both effects are probably not independent of each other. Others, such as Brochmann & Gleditsch (2006b), Hensel et al. (2006), Hensel & Brochmann (2007), Zawahri & Mitchell (2008), pool the data and analyse it at the basin(or river)-dyad-year, but their statistical analyses ignore that this creates non-independent observations.[8] I try to explicitly account for both interdependencies between dyads located in the same basin (some basins are shared by more than two countries) and interdependencies between basins shared by the same dyad (some dyads share more than one basin) by introducing respective spatial lags.

[7] Considering both conflictive and cooperative events, is in line with Zawahri and Gerlak's advice to jointly study cooperation and conflict, because both might occur simultaneously in the same river basin (Zawahri & Gerlak 2009, 218).

[8] Brochmann & Hensel (2009*b*) use standard errors clustered on the dyad, but this does not account for interdependencies on the river or basin level (many of the rivers in their sample are located in the same basin, for instance Iguazu, Paraguay, Parana, Pilcomayo, and the Uruguay rivers are all part of the La Plata basin).

The remainder of this paper is structured as follows: section 4.2 delineates the theoretical framework and presents empirically testable hypotheses. Following the theoretical part, section 4.3 is dedicated to the research design and discussion of some methodological questions. The empirical part is completed by the discussion of results (section 4.4), and section 4.5 contains my conclusions.

4.2 Theoretical Framework

According to Tir & Ackerman, "the resources rivers offer are often not purely public (defined as non-rival and non-excludable) or private (defined as rival and excludable) goods. Instead, they are partially rival and partially excludable, making them collective goods or common pool resources" (Tir & Ackerman 2009, 3). Whether or not these resources can be considered as non-rival and non-excludable depends both on river geography and on the issue at stake. Border-demarcating rivers, for instance, are non-excludable. Whether or not they are non-rivalrous depends on the issue at hand. In terms of water quality, one can easily see non-rivalry. All countries riparian to a border-demarcating river benefit from water quality and suffer from water pollution to more or less the same extent (that is, potential externalities are reciprocal (cf. Barrett 1994)). Water quality in border-demarcating rivers thus comes closest to a public good. In terms of water quantity, however, a country might overexploit the resource (rivalry), hence characterising a common-pool good situation. In upstream-downstream situations, clear power asymmetries between up- and downstream countries prevail. The main concern here, therefore, are unilateral transboundary externalities.

In setting up the theoretical argument, I therefore distinguish between different scenarios. Depending on the circumstances, I expect different incentives regarding potential government action. The next sections consider the effect of democracy and interdependencies on intergovernmental cooperation, distinguishing potential asymmetries emanating from different geographical settings and issue areas of concern.

4.2.1 Democracy

The gist of the Kantian peace argument is that democracies do not fight each other. Many scholars have extended this argument to show that in addition, democracies tend to behave more cooperatively.

In order to better understand governments' behaviour in the case of shared public goods (or public bads,[9] respectively), two questions have to be addressed: First, do governments have an incentive to provide their constituents with public goods in the first place? Second, if governments have an incentive to provide their constituents with public goods, do they choose to cooperate with other countries in the case of shared public goods (or public bads)? With respect to common pool resources, the crucial question is whether or not countries have an incentive to

[9] Public bads are simply defined as the counterpart to public goods. Whereas public goods have the connotation of people benefiting, public bads imply the reverse. For example, clean air is considered a public good, whereas air pollution might be defined as a public bad. In both cases non-rivalry and non-excludability apply.

collaborate to mutually beneficially manage the shared resource. Building on the literature on the domestic provision of public goods, I develop an argument regarding the first question in section 4.2.1.1, and then proceed to governments interaction in section 4.2.1.2.

4.2.1.1 Provision of public goods

There exists a vast literature on the determinants of domestic public goods and domestic environmental quality provision more specifically. Whereas many economic studies highlight the relationship between per capita income and environmental quality (Grossman & Krueger 1995), more recent studies from the field of political science stress the importance of political variables such as democracy (c.f. Li & Reuveny 2006, Fredriksson & Wollscheid 2007, Ward 2008, Bernauer & Koubi 2009). Many studies on monadic provision of public goods have shown democracies to outperform autocracies in providing public goods (cf. Fredriksson & Wollscheid 2007, Ward 2008, Bernauer & Koubi 2009). It should be noted, however, that empirical applications to environmental quality have led to mixed results regarding different types of pollutants (c.f. Midlarsky 1998). Conclusive results are obtained only in the case of SO_2 concentrations. Non-democratic regimes, in turn, tend to underprovide public goods (Olson 1993, McGuire & Olson 1996, Deacon 1999). At the core of the argument why democracies outperform autocracies is the assumption that, in order to survive in office, political leaders must satisfy their "winning coalition" (the group of people whose support is crucial to stay in office) to ensure continuous support (Bueno de Mesquita et al. 2003, 30). Non-democratic political leaders typically depend on the loyalty of a small elite. Such a small winning coalition can beneficially be compensated with private goods, only beneficial for those supporting the leader, to ensure loyalty of a privileged few (Bueno de Mesquita et al. 2003, 197). The benefits of public goods provision are uniformly distributed among the population. If non-democratic political leaders decided to spend more money on public goods provision rather than accumulating rents and supplying their supporting elite with private goods, the leading elite would bear disproportionately high opportunity costs of spending tax revenue on public goods provision. The median voter in a democracy, in turn, incurs lower marginal cost of public goods provision. In addition, democratic leaders are responsive to a larger winning coalition. They consequently have to resort to the provision of public goods to ensure political support, given that they lack sufficient resources to reward their supporters with high levels of private goods. According to the weak loyalty norm in democratic regimes, supporters might defect to opposition parties (or opposing candidates) if their demands are not satisfied. Democratic leaders are thus responsive to and accountable for public demand. Bueno de Mesquita et al. (2003) conclude that "the size of a government's winning coalition is a significant factor in promoting public-goods production" (Bueno de Mesquita et al. 2003, 198). The relevant dimension of democracies in this respect thus is accountability, manifested by the fact that the executive is recruited by competitive elections.

Applying this argument to the given context implies a rather strong assumption, namely that citizens' support depends on the provision of goods such as clean water. However, many rivers are of great economic importance, especially with regard to water quantity. In addition, pollution levels can be crucial if rivers supply drinking water. Accordingly, the link between democratic

structures and government action regarding shared rivers might be much stronger for rivers of substantial importance to the population, be it with respect to sanitation or for economic reasons, such as generation of electricity (hydropower), than for less important rivers. In the empirical application, I therefore control for river characteristics, such as the population living in the basin area, environmental awareness and concern.

Having laid out under which circumstances I expect governments to have an incentive to provide public goods, the next section addresses the question of whether governments choose to cooperate with other countries in the case of shared public goods, public bads, or common pool resources.

4.2.1.2 Government interaction

Bac (1996) sees government interaction regarding transboundary public goods as a dynamic game of incomplete information. In his set-up, the two states play a repeated game, where both countries prefer the other country to contribute to the provision of the public good and not having to incur the cost of provision themselves. Neither country knows the other country's type, which can be either H (high valuation of environmental quality) or L (low valuation of environmental quality). The main idea is that if the other country does not abate, H-types eventually abate and thus reveal their type. Accordingly, whenever a country abates, it is of H-type with probability one.

Applying these ideas to the case at hand, one could argue that democracies would have a hard time hiding their type in the first place. This is because government action is transparent[10] to citizens which implies that it is also observable by other riparian countries, whereas in the case of an autocracy the assumption that the other country does not know the type might be more plausible. Accordingly, in a mixed dyad, one would expect democracies to act (if they were of the H type) and autocracies not to reveal their type and thus free-ride on the democracy's efforts.

Yet, given the repeatedness of the game, potential equilibria also depend on how heavily governments discount the future. For instance, if both countries' discount factors are higher than a certain threshold, it can be shown that abatement is independent of incomplete information (separating equilibrium). On the one hand, one might expect democratic leaders to behave rather myopically given that they have the short-term goal of surviving the next election rather than relying on long-term effects of their current action. This would justify the assumption that democratic leaders heavily discounted future payoffs. This might give rise to a war of attrition outcome in which abatements critically depend on prior beliefs. On the other hand, Congleton argues that rather than democracies, "authoritarians [...] probably tend to have a shorter than average time horizon given the high turnover of authoritarian regimes" Congleton (1992, 417). Higher turnover of authoritarian regimes also implies that democratic leaders are much more likely to have another turn in office (even if they were outvoted once) than their authoritarian counterparts, which again implies a higher valuation of future payoffs. Whether or not demo-

[10] It is a common assumption that democracies are more transparent than other regimes; empirical evidence is provided by Rosendorff & Vreeland (2006)

cratic leaders discount the future more heavily than their non-democratic counterparts is thus theoretically controversial.

An implicit assumption by Bac (1996), made more explicit by Taylor & Ward (1982, 354) is that "each player can profitably provide some of the public good alone, though he would prefer not to contribute when the other does". The authors suggest a repeated game of chicken to model such situations where each player prefers the other to provide the good. This chicken supergame gives rise to several equilibria (Taylor & Ward 1982, 366–367), with the likelihood of a fully cooperative equilibrium rising "with decreases in the rate at which players discount future payoffs" (Taylor & Ward 1982, 367). This implies that if governments care about future interactions with other riparian countries, cooperation should become more likely.

If the above assumption that "each player can profitably provide some of the public good alone" (Taylor & Ward 1982, 354) does not hold, that is if "a single individual's contribution is insufficient to provide any public good, or provides only very little of it", Taylor & Ward (1982, 353) argue that each player might prefer to defect if the other player defects, "but may prefer to contribute if the other contributes too" (Taylor & Ward 1982, 353). The authors argue that in such assurance games it is unlikely to have a collective action problem, and that the pareto-optimal outcome of both countries cooperating is likely to occur (Taylor & Ward 1982, 354). However, under incomplete information, mistrust might prevent countries from taking the risk of cooperation.

Coming back to the situation of transboundary rivers, the latter assumption appears more plausible. Even if one country made an enormous effort in avoiding pollution, this would help little if the other country kept polluting heavily. This is even more obvious when it comes to common pool good situations, such as water withdrawal, where each country might over-exploit the resource. Borrowing from a similar argument by Levy & Razin (2004) on peaceful conflict resolution, it could then be argued that successful provision of transboundary public goods or management of common pool goods depends on mutually beneficial concessions. This means that both countries affected by a common public bad would need to abate, if they wanted their citizens to benefit from the public good or sustainably manage a common pool resource. Yet, such concessions are linked to certain costs, in the case at hand the costs of abatement, or the cost of withdrawing less water for irrigation, etc.. These costs are the highest in the case of one country conceding far-reaching commitments while the other country in the respective dyad makes no concessions whatsoever. In such a case, the first state would need to bear the full costs of abatement, whereas the second would benefit without any associated costs. This implies that both countries' governments would receive higher pay-offs (in terms of better environmental quality or water availability) if they cooperated, but, with imperfect information, they have an incentive to unilaterally defect. A government has no incentive to agree on mutual concessions if cooperation by the respective other government is not guaranteed. Such problems of commitment and distrust are also highlighted by Ward (1996, 859) in a game-theoretical paper on FCCC. In Levy & Razin (2004)'s setup, each government would receive higher pay-offs if it defected unilaterally. In the given context of river events, it seems most plausible that governments interact repeatedly. In this case, there is a crucial difference between democratic dyads and all other dyads with respect to this problem: the risk of defection is rather low in democracies given that information on possible government action is public and thus observable by the other country's authorities (Levy & Razin 2004, 03) and its citizens. This is why democratic

dyads are expected to be able to coordinate on mutual concessions (Levy & Razin 2004, 03). Transparency can facilitate trust, since defection would easily be observed. The dimension of democracy that is of importance in this context is thus transparency.

Furthermore, if countries play conditionally cooperative stategies – that is, they only cooperate if the other side does so – one side may threaten the other side that it would itself resort to conflictive strategies once the other side defected (cf. Barrett 1994, 28). Given audience costs in democracies such threats might be more credible depending on the regime type.

Bergin et al. (2005, 25) emphasise that cooperation to reduce transboundary pollution requires trust and democratic governments have more reason to trust each other than to trust their non-democratic counterparts. Consequently, democratic governments can collaborate with their democratic neighbours – without the fear of being cheated – in providing transboundary public goods or managing common pool resources, as long as their citizens demand such action and the gains from acting in line with their constituents' preferences outweigh the respective costs of provision (in the case at hand abatement costs). That is, given demand for transboundary public goods, electoral punishment should be applicable to the context of transboundary resources. The reason for this is that "the superior ability of elections in democracies to constrain leaders prompts democratic rulers to be more cooperative internationally than their nondemocratic counterparts" (Mansfield et al. 2002, 480).

A further reason why democracies tend to be more cooperative is that they usually share some common values, such as a shared culture of cooperation and a habit of peacefully resolving domestic conflicts that may translate to the international level (cf. Maoz & Russett 1993, Russet 1993, Layne 1994, Levy & Razin 2004, Zinnes 2004). Accordingly, a democratic government can safely expect another democratic government to act sensibly and to be trustworthy and thus comply with its commitments (cf. Hamner 2009, 22). Hence, democratic leaders perceive that possible gains from cooperation with other democratic governments outweigh the risk of defection. In conjunction with the arguments provided above (section 4.2.1.1), namely that democracies are better providers of public goods, these considerations lead to the following hypothesis:

> **H1a:** The higher the level of democracy[11] in a river-sharing dyad, given citizens' demand, the more efforts are made by the respective governments towards mutually beneficial river basin management.

This hypothesis is further supported by arguments put forward by Midlarsky (1998, 346). He posits that "[...] regime responsiveness, political learning especially as the result of mutual identification, and the tendency toward cooperation in international institutions [...]" are important aspects of democracy for both peaceful relationships between democracies (Kantian peace) and environmental protection. Empirically, Hensel et al. (2008, 136) find a negative impact of democracy on militarised settlements of river claims and a positive impact on peaceful settlement attempts.

[11] As laid out in the section on operationalisation, I understand the level of democracy as that of the initiator in directed interactions and – following the weakest link logic – use the lower level of democracy in a dyad in the case of mutual action.

4.2.1.3 Transboundary externalities

In terms of asymmetries and geographic context factors, the above section has discussed transboundary environmental problems affecting both countries to more or less the same extent. An example of such a problem is pollution in border demarcating rivers. However, many rivers cross national borders, thus bearing the potential of upstream-downstream problem settings. Such situations differ from those described above in that the downstream country is dependent on the upstream country to attend to water quality and water quantity, whereas the latter can act independently. Accordingly, we are no longer dealing with a transboundary public good/ bad, or common pool good, but with a unidirectional transboundary externality. In their study on institutionalised cooperation (river treaties), Song & Whittington (2004) consider both river geographic and dyad-specific domestic variables. In analysing treaty data provided by the Transboundary Freshwater Disputes Database (TFDD) and FAOLEX, they find that fewer treaties are concluded in upstream-downstream settings. They thus point to a crucial difference between such settings (upstream-downstream) and the border-demarcating context described in the previous section (4.2.1.2).

Several studies on upstream-downstream settings rely on the arguably rather strong assumption that the upstream, or emitting country does not suffer from pollution at all (c.f. Petrosjan & Zaccour 1996, Jørgensen & Zaccour 2001). This assumption appears plausible in cases of water scarcity, where the upstream country might fully exploit the shared resource, causing water scarcity in the downstream country. When water quality is at stake, it only holds for extreme cases in which all upstream pollution is caused by point source pollution just before an international border and no pollution occurs before the river reaches the border of a downstream country, or if at all, such pollutants are transported downwards before causing any damage to the upstream country's environment. A weaker assumption is that upstream-downstream situations are asymmetric in the sense that the upstream country is in an advantageous situation, but nevertheless it also suffers from its own pollution, albeit to a lesser extent than the downstream country. That is, upstream countries may reap direct benefits themselves from abating pollution. Given that they still have to bear the cost of pollution reduction, they should only be interested in cooperating beyond the level they would achieve if they were not affected themselves. In other words, upstream countries are expected to cooperate if the benefits from cooperation outweigh the cost of abatement. The expected cooperation-enhancing effect of democracy thus depends on the upstream country's affectedness. I therefore hypothesise:

> **H1b:** The higher the upstream country's level of democracy and the higher its own affectedness, the more efforts are made by this country's government towards mutually beneficial river basin management.

4.2.2 Political and Economic Interdependency

According to liberal theories, financial openness and trade interlinkages[12] foster cooperation (Oneal & Ray 1997, Oneal & Russett 1997). The cooperation-enhancing effect of interlinkages is of particular importance when dealing with upstream-downstream situations, as interlinkages might weaken the effect of asymmetries. Relying on Durth (1996) and Marty (1997, 2001), Bernauer (2002) describes such upstream-downstream situations as a deadlock game, where the upstream country's dominant strategy is to pollute, whereas the downstream country's dominant strategy is to reduce pollution. However, as mentioned above, this approach appears to oversimplify the situation, since intergovernmental actions may be (infinitely) repeated (c.f. Bannett et al. 1998, 64), giving raise to additional equilibria other than the deadlock pattern. Petrosjan & Zaccour (1996, 837) show that in the repeated game, there indeed exists a cooperative Nash equilibrium. Under certain conditions, cooperative strategies are time consistent, that is, players never diverge to a noncooperative strategy at any intermediate date (Petrosjan & Zaccour 1996, 837).

Bhaduri & Barbier (2008) proceed from a slightly different assumption, namely that countries display a certain degree of altruism in the sense that they care about a good political relationship with other countries. Expecting the other country to favour a good political relationship, the upstream country diverts less than the individually rational amount of water and the downstream country agrees to a lesser amount of water being received from the upstream country, independent of side payments (Bhaduri & Barbier 2008, 02). The resulting water allocation is Pareto efficient and depends on the countries' altruism parameters (e.g. if both countries are equally altruistic, the countries solve the social planner's problem). The altruism parameter is derived via median voter preferences in both countries.

Notwithstanding the upstream country's advantagous situation, one might thus observe cooperation in upstream-downstream country pairs under certain conditions. The main reason is that governments are usually concerned about the (future) relationship with their neighbours, be it because of economic interdependencies or because they are linked via agreements on other issue areas (c.f. Bannett et al. 1998, Carraro & Marchiori 2003, Dinar 2009*b*) or simply because they care about possible future interactions, and "condition actions in one time period on observed, past actions" (c.f. Bannett et al. 1998, 64). In terms of trade interdependencies, both Bernauer & Kuhn (2009) and Sigman (2004) argue that trade interdependencies facilitate implicit side-payments and issue linkages so that the upstream country feels inclined to contribute to lower pollution levels, if the downstream country takes advantage of a possible asymmetric trade dependency.

These insights could easily be incorporated in Bhaduri & Barbier (2008)'s model by substituting the altruism parameter with an interlinkage weight. That is, rather than having a country's concern for the other country depend on the expectation of the latter's willingness to have a good political relationship, one could model the concern to depend on the degree of interlinkages that might induce countries to be concerned about each other.

[12] As Dorussen & Ward (2008) show, such interlinkages need not necessarily be direct, but also indirect interlinkages might play an important role

Whereas Bernauer & Kuhn (2009) find rather mixed results on the effect of trade ties on transboundary water pollution, Sigman (2003, 2004) finds that rivers shared by dyads with stronger trade ties are less polluted, and Tir & Ackerman (2009) show that economic integration fosters the conclusion of bilateral environmental treaties. Furthermore, Neumayer (2002*b*) demonstrates that trade openness promotes multilateral environmental cooperation. He argues that multilateral cooperation might be a signalling device to facilitate future cooperation (Neumayer 2002*b*, 816).

Summing up, there is reason to believe that strong trade-induced relationships create opportunities for agreeing on means to internalise transboundary externalities and to provide transboundary public goods. Consequently,

> **H2a:** The higher the level of economic interdependence in a river-sharing dyad, [13] the more efforts are made towards mutually beneficial river basin management.

Other forms of interaction, such as political agreements also offer the possibility to change governments' incentive structures. In fact, the Kantian peace literature highlights both political and economic interdependence (Russett & Oneal 2001). Behaving uncooperatively on transboundary river issues might damage a country's international reputation. This, in turn, diminishes a government's prospects of successful negotiations on other issue areas with the same actors involved. Therefore,

> **H2b:** The higher the level of political interdependency in a river-sharing dyad, the more efforts are made towards mutually beneficial river basin management.

Whereas the effect of interdependencies is expected to matter for both border-crossing and border-demarcating rivers, the size of its effect might differ depending on river geography and thus countries' affectedness.

4.2.3 Salience and Severity

The arguments presented in the preceding subsection rely on the simplifying assumptions that governments face the same incentive to react to or ignore transboundary water issues, regardless of the characteristics of the issue at hand. However, there is reason to believe that both the severity and salience of water issues alter government's incentives to deal with them. If no real problem existed, such that the costs of abatement came close to zero, cooperation might become more attractive. In this case, political leaders can only gain: they face practically no abatement costs and cooperation might improve their reputation, thus putting them in an advantageous situation in future negotiations on other issues with the same actors involved. Given that cooperation might entail some costs in its own right (such as transaction costs), I

[13] In principle, this holds for any type of government. However, democracies generally tend to have higher interlinkages with other countries both in terms of trade and IGO co-membership.

expect to observe rather low levels of cooperation, such as governmental visits and talks or policy expressions that do not incur any substantive costs rather than high-level cooperation, such as the establishment of a treaty. Otherwise, the ratio of costs to benefit would be rather high. Although severe problems are not necessarily associated with higher abatement costs, especially if adequate technologies are readily available, severity and abatement costs are often positively correlated. Dinar (2009*b*), for instance, argues that while moderate levels of scarcity might induce the necessity to cooperate, high levels might deter countries from cooperation because of prohibitively high costs. It thus appears reasonable to assume that the more severe the environmental problem under consideration, the higher the costs of abatement. If abatement costs are high, autocratic leaders have little incentive to tackle the respective environmental problem. This is because in autocratic regimes it is the elite that bears a disproportioned share of the cost of providing public goods, since spending money for the population as a whole implies that less money is left to pay rents for the elite. Given that autocratic leaders depend on the support of the elite rather than the population as a whole, it would be more rational to spend less money on public goods. In essence, the ratio of costs to benefits of abatement is higher than that of providing private goods to the leading elite. Therefore,

> **H3:** The more severe a transboundary water issue and the more autocratic the affected country, the less political leaders cooperate with their neighbours sharing the problem.

However, under certain circumstances, democratic leaders have an incentive to act in the case of severe problems inspite of the associated high costs, namely if the ratio of costs to benefits from acting is lower than that of refraining from tackling the problem. As aforementioned, this incentive is present if the risk of electoral punishment outweighs the costs of abatement. I argue that in this particular case, the crucial element in shaping governments' incentives to act is issue salience, where salience is defined as referring to those issues that feature high on voters' preferences. That is, if salience is high, such problems are prone to alert the electorate, which might punish the incumbent by defecting to opposing parties. Both severity and salience thus alter the incentive structure of the governments involved. Although salience increases the pressure on democratic leaders to act, whether or not they chose to cooperate with river-sharing countries presumably also depends on their relationship to their neighbours and possible power asymmetries. In purely democratic dyads, governments in both countries are in a similar situation. Under the assumptions of public goods/ bads (polluted border rivers, lakes), I would thus expect them to cooperate in order to provide the public good to their citizens. This line of reasoning is in accordance with Hamner (2009), who highlights both the challenges and the opportunities to cooperate created by severe droughts (Hamner 2009, 40–41).

> **H4a:** The more salient a transboundary water issue in border-demarcating rivers (or lakes) and the more democratic the affected countries, the more likely political leaders are to resort to cooperative measures to solve the problem.

Considering geographically induced context dependency, power asymmetries might affect whether or not political leaders choose to cooperate in upstream-downstream situations. Despite its advantageous situation, even if the upstream country's government faces extreme pressure by

its electorate and might thus choose a rather conflictive approach (i.e. unilaterally withdraw all water for its own citizens), the downstream country's government, also faced by domestic pressure, might be willing to incur even higher side-payments to ensure cooperation with the upstream country. Accordingly, I expect a curvilinear relationship between salience and cooperation/conflict in that salience promotes both extremely conflictive and extremely cooperative events, especially in democratic dyads.

> **H4b:** The more salient a transboundary water issue in an upstream-downstream setting and the more democratic political leaders, the more extreme (highly cooperative/ conflictive) the measures they resort to.

4.3 Research Design

I empirically test the above theoretical claims on time-series-cross-sectional (TSCS) data of country pairs (dyads) sharing a river basin. This includes riparian states of both transboundary and border demarcating rivers worldwide.

The main challenge regarding empirical tests is to collect data on transboundary river events. I therefore dedicate the next paragraphs to data collection and conclude this section by discussing certain econometric considerations.

4.3.1 Variables and Operationalisation

4.3.1.1 Dependent Variable

The dependent variable is a river-sharing country pair's degree of conflictiveness/cooperation in interaction on the shared resource. To assess the degree of conflictiveness and cooperation, I rely on event data on governments' interaction regarding joint management, water quality and water quantity. Whereas most independent and control variables can be obtained from secondary datasources as listed in table 4.7 in the appendix, the most obvious reason why there is little quantitative empirical work on the management of international freshwater resources is the lack of adequate data on the dependent variable. To overcome data shortage, I constructed a new dataset on events over shared waters. This new dataset covers more than 260 river basins and 130 countries over eleven years.

I retrieved information on water interactions from local newspapers made accessible through BBC Monitoring (`http://www.monitor.bbc.co.uk/`). This database provides translations of local media sources from around the world and thus lends itself to extensive content analysis to create event-datasets relying on local news rather than on western press agencies such as Reuters. This is especially helpful for the project at hand, where events that are of local (or even regional) importance, but do not feature high on the international agenda, are relevant for the topic of study. It thus allows us to capture events not reported by major western press agencies and to avoid respective bias.

Based on reported newspaper events, I code the degree of cooperation/ conflictiveness of each event in integers ranging from -6 (most conflictive) to +6 (most cooperative). This categorisation relies on, but differs quite considerably from those of the TFDD (Yoffe and Larson 2002). An illustration of the data coding can be found in appendix 4.6.2, more details are provided in Kalbhenn (2009*b*). Some governments tend to re-negotiate the same problem over and over again. I therefore aggregate all events that pertain to the same issue by coding the dependent variable as the median cooperation/conflict score within the same event, if the latter is split into several interactions. I then apply a modified version of the approach suggested by Crescenzi & Enterline (2001) to account for the dynamics in interstate interaction. The main idea behind Crescenzi and Enterline's approach is that interstate relationships are defined by previous interactions, whose influence on the perceived current interstate relationship depends on how much time has passed between such interactions, the accumulation of occurrences of conflict and cooperation, and on current cooperative and conflictive "shocks", i.e. events that take place between two states at time t. This leads to the following measure of interstate relationships:

$$\begin{aligned} y_{i,j,t} &= \left(e^{-\frac{\text{confl temp dist}}{\text{confl hist}_{i,j,t+1}}}\right) y_{i,j,t-1} \\ &- \frac{\text{degree of confl}}{\text{confl temp dist}_{i,j,t}} + \frac{\text{degree of coop}}{\text{coop temp dist}_{i,j,t}}, \end{aligned}$$

where the subscripts i, j, and t refer to the basin, dyad, and year respectively. "confl temp dist" and "coop temp dist" are short for conflict- and cooperation temporal distance. They are operationalised via the time that has elapsed since the last cooperative or conflictive event. The "degree" of conflict and cooperation is the previously explained cooperation/conflict score. The first term of expression 4.1 differs from what Crescenzi & Enterline (2001, 418) propose as it only considers conflict. Crescenzi & Enterline (2001, 418) in turn have event, i.e. cooperation and conflict, temporal distance in the numerator and event history in the denominator. The idea behind this decay function weighing the impact of past interaction is that "in the absence of interaction between two states, the relationship should dissipate" (Crescenzi & Enterline 2001, 417). I opt for only including conflict in the decay function, since cooperation might simply cease after a certain number of events, because riparian states have agreed on how to deal with their common resource, i.e. by establishing a treaty stipulating certain pollution targets. Although the conclusion of a freshwater treaty does not preclude these states from cooperative interactions (i.e. reporting on their compliance with the agreement, etc.), such interactions are rather unlikely to be reported by local newspapers. A graphical illustration of the aggregation can be found in appendix 4.6.2.

4.3.1.2 Independent Variables

Democracy According to the theoretical framework of this paper, two measures of democracy are relevant. On the one hand, I rely on Bueno de Mesquita's argument on democratically elected leaders' incentives to provide public goods in order to survive in office (section 4.2.1.1). On the other hand, I argue that because of the transparency of democratic systems, transbound-

ary actions are more likely in democratic dyads (section 4.2.1.2). Whereas the former largely relies on the concept of the winning coalition captured by a respective dataset by Bueno de Mesquita (The Logic of Political Survival Data Source; Bueno de Mesquita et al. (2003)),[14] the latter refers to institutional aspects of democracy that are reflected by the polity IV dataset by Marshall & Jaggers (2002) (updated and modified by Gleditsch (2008)). I use both measures in alternative specifications. Given that Bueno de Mesquita builds on the polity IV dataset, I do not expect results to change substantially. Rather, using different measures of democracy is a means of checking the robustness of my results.

Obviously, there are different means of assessing dyadic democracy (Goertz 2006, 03–05). For those events that emanate from a particular country and are directed[15] toward another country, I rely on the initiators democracy score. An example for such an event is the Bulgarian environmental minister sending a letter to his Serbian counterpart proposing a joint expert group on waste water discharge in the Danube (initiator: Bulgaria, target: Serbia). In case of mutual events, e.g. joint talks on pollution levels, I follow common practice (cf. Russett & Oneal 2001) and use the weakest link logic. That is, the dyadic democracy score assumes the democracy score of the country in the dyad with the lower (monadic) democracy score of the two.

Citizens Concern Hypothesis 1 not only requires data on democracy, but also whether citizens demand government action. Obviously, this can only be tested for democratic governments, which is why I rely on a subsample when including this variable. I have tried different proxies for citizens' general environmental concern using data on green parties' vote share compiled by Armingeon et al. (2008), an item of the World Values Survey on the willingness of incurring a tax increase for better environmental quality, and the average emphasis placed by parties on the environment (Cusack & Fuchs 2002, adapted by Hugh Ward). Unfortunately, all indicators are only available for a small subset of country-years, such that including the data dramatically reduces the original sample. In case of the World Value Survey, the sample reduction led to the dependent variable being constant making the use of this proxy unfeasible. Below, I report results using the average emphasis placed by parties on the environment (green emphasis). Given that the environment can be considered a valence rather than a positional issue, all parties are expected to emphasise it to the extent to which the public are interested so that this proxy appears a good indicator for citizens' concern.

Interdependence: trade dependence Trade dependence is measured by the ratio of the sum of one country's exports to and imports from the other country in the dyad to the total sum of the first country's exports and imports (cf. Bernauer & Kuhn 2009, 16). Data are retrieved from

[14] I have recoded the so-called W_{mod} from the original Logic of Political Survival Data using the updated polity IV Data by Gleditsch (2008). This forces me to use the measure of winning coalition rather than winning coalition over selectorate due to lack of data on the legislative selection data. Given that both measures correlate almost perfectly (which is presumably due to the fact that whether or not a country's legislature is elected or not is highly correlated with a country's winning coalition), this seems to be a minor issue.

[15] The direction is coded within the scope of the event data collection described above. I include a variable indicating whether cooperation is mutual or "directed", i.e. one country approaches the other and if so, which country is the initiator of the event.

version 4.1 of the expanded trade and GDP dataset by Gleditsch (2006) and augmented with data from the IMF direction of trade statistics.[16] [17]

Interdependence: Political integration I count the number of joint memberships in international organisations relying on data by Pevehouse et al. (2007).[18]

Severity of problem With respect to the severity of environmental problems, I rely on pollution proxies and further consider water scarcity. Regarding pollutants, data on point- and non-point sources are provided by the Global Environmental Monitoring System (GEMS). However, as shown in Beck et al. (2009), such data do not come without problems and there are serious doubts about the representativeness of such pollution figures. I therefore proxy pollution by the population density in a basin to assess severity in the case of (potential) water quality events (LandScan 2008).

Water scarcity (assessed via precipitation and temperature in a basin area) measures severity in the case of (potential) water quantity events and is assessed using data provided by Mitchell (2004).

Following Dinar (2009*b*) one might consider including the squared term of severity indicators to allow for an inverted U-shaped relationship between, for instance, scarcity and cooperation. However, the coefficient on the squared term turned out to be statistically insignificant, which is why respective results are not reported below.

---

16 To allow for indirect links, I use the "third party linkage statistic" proposed by Dorussen & Ward (2006):

$$\text{ln triadic trade links}_{ij} = ln\left(\sum_{k\neq i,j} v(i,k)v(k,j)\right), \tag{4.1}$$

where v refers to the value at the edge of a network node. That is, the value at the edge is higher if two countries i and k are not only linked by direct trade relationships, but also via third parties.

17 One might argue that rather than pure trade relationships, other financial flows such as FDI are important measures of countries' economic integration. Zeng & Eastin (2007, 991) point out the importance of measuring both FDI and trade openness to fully capture global economic integration. Similarly Araya (2002), Guerin & Manzocchi (2006), and Büthe & Milner (2008) highlight the complementarity of trade and FDI. For none of the models estimated below, the coefficient on FDI was statistically singnificant. Data for FDI is taken from (OECD 2008).

18 Further, I use (Dorussen & Ward 2008, 197)'s measure of third party IGO links:

$$\text{links3}_{ij} = ln\left(\sum_{k\neq i,j} v(i,k)v(k,j)\right),$$

with the notation corresponding to the one in expression 4.1.

Given that third-party- and direct links are highly correlated for both trade and IGO interlinkages ($> .8$, depending on the respective sample), I run reduced models only including direct links.

Salience I capture the *salience* of water issues by coding the degree of citizens' concern as expressed in press articles. The reliability of this measure is of course questionable if the press in the respective country is not free. Accordingly, I cross-check with reports from the other country in the respective dyad. Further, I control for the neutrality of the sources I use (see below).

To test hypothesis 4b, predicting a curvilinear relationship between salience and cooperation/conflict levels in upstream-downstream settings, I transformed the salience measure to be the positive square root of the original salience value for cooperation and the negative square root for conflictive interaction to assess whether salience leads to more extreme events (both in terms of conflict and cooperation).

4.3.1.3 Control Variables

Press Freedom/ Source neutrality The main caveat when using newspaper articles is that information is reported selectively (Franzosi 2004, 167). However, Franzosi (2004, 172) concedes: "perhaps all data are biased in some ways. What is important is to know the type and form of bias in order to be able to gauge its effect on evidence and conclusions". Accordingly, I introduce a variable indicating the neutrality of the media source, based on whether or not reporting is independent of the government. These data are retrieved from the World News Connection (WNC).[19] For those sources for which WNC does not report an assessment, I use the issuing country's press freedom score as reported by freedomhouse.

Trade openness Following common practice, I account for trade openness by including the ratio of the sum of exports and imports to GDP as a measure of exposure to foreign trade. I take logs to account for the non-normality of this measure.

Environmental commitments Countries that are generally more committed to international environmental protection might also do so in the freshwater realm. I therefore control for the number of multilateral environmental agreements a country is a party to in each year. Data are adapted from Mitchell (2002-2008*b*) and the environmental treaties dataset by CIESIN (Columbia University: http://sedac.ciesin. columbia.edu/entri/).

Ideological affinity Governments might be more willing to cooperate with those governments with whom they share common values. I therefore introduce a variable controlling for ideological affinity. This concept is operationalised via voting patterns in the United Nations (Gartzke & Jo 2002). That is, countries that tend to vote similarly are conceived as being ideologically closer to each other than countries that usually vote in opposite ways.

[19] `http://wnc.fedworld.gov/`

Economic strength and capabilities Apart from the willingness or incentives to sustainably manage shared resources, governments also need to have the ability to do so (Appelgren & Klohn 1999, Recchia 2001). I therefore control for economic strength (measured as per capita income), as reported in the Penn World tables, version 6.2 (Heston et al. 2006).[20]

Further, I include total GDP as well as the difference in GDP and GDP per capita in a dyad to capture power asymmetries and relative capabilities. For instance Lowi (1993*b*, 192–193) argues that cooperation over shared waters depends on the distribution of power between riparians. Dinar et al. (n.d.) expect cooperation between riparians to occur in both symmetric and asymmetric cases, and argue that "cooperation in asymmetric contexts will be facilitated by the wealthier state's ability to provide incentives and inclination to create 'good will' with the poorer riparian" (Dinar et al. n.d., 07). I use the log of both GDP and GDP per capita because of skewed distribution.

EU membership I include a joint EU membership dummy to control for possible effects of common EU legislation.

Basin Characteristics Finally, the importance of a basin should be taken into consideration. This is captured by basinsize and the number of riparians.

Further, to proxy whether or not the upstream country is indeed suffering from its own pollution, I control for the share of the basin in the upstream country when testing hypothesis 1b. This is a rather crude proxy, since large industrial plants could still be based downstream just before the border to downstream riparians. Nonetheless, the chances are higher that the upstream country is affected by its own pollution if a basin occupies a larger part of its territory.

Some dyads share several basins. I account for whether or not upstream-downstream country pairs share basins with other flow directions (so that they reverse their role of up- and downstream country, respectively). In the case of border-demarcating rivers I use a dummy for "mixed" basins, i.e. those basins that only partly demarcate a border.

4.3.2 Econometric Approach

Some rivers are shared by just two countries, such as the Don, shared by Russia and the Ukraine. Others are shared by three, four or even more countries. Zimbabwe, South Africa, Mozambique, and Botswana are all riparian to the Limpopo, yielding six country pairs. The Danube with 17 riparians (136 country pairs) is the largest basin in terms of the number of riparian countries. Furthermore, each of these country pairs might share more than one river. Russia and the Ukraine, for instance, are both riparian to the Dnieper. Chile and Argentina share a total of 17

[20] I use GDP rather than composite capability measures, such as the Correlates of War Composite Index of National Capability (CINC) score, because the latter is highly collinear with other variables in the model and is based on indicators such as military expenditure, military manpower or iron and steel production that are not relevant for the type of cooperation and conflict considered in the study at hand.

basins (the maximum number observed). This gives rise to a non-nested structure of basin-dyads with 783 dyads, 263 basins, and 1367 basin-dyads (depending on the respective subsample).

I expect neither the interaction of dyads in the same basin nor the interaction taking place in different basins shared by the same dyad to be independent of each other. I therefore introduce spatial lags, accounting for both types of interdependencies, by specifying two $NT \times NT$ block-diagonal binary[21] spatial weights matrices, $\mathbf{W}^b$ and $\mathbf{W}^d$ and introducing the respective spatial lags $\mathbf{W}^b\mathbf{y}$ and $\mathbf{W}^d\mathbf{y}$ on the right-hand side of my regression equation. Entries in $\mathbf{W}^b$ assume the value 1 if both the row- and column-basin coincide, 0 otherwise, diagonal entries are 0. Likewise, entries in $\mathbf{W}^d$ assume the value 1 if both the row- and column-dyad coincide, 0 otherwise, diagonal entries are 0. Both spatial weights matrices are row-standardised (i.e. each cell is divided by the row sum).

Several estimators have been proposed for time-series-cross-sectional models with spatial lags.[22] Franzese & Hays (2007) assess different specification and estimation choices[23] both in terms of their asymptotic properties and small sample performance. They conclude that "S-ML seems to offer weakly dominant efficiency and generally solid performance in unbiasedness and SE accuracy, although it sometimes yields relatively little in reduced bias or enhanced efficiency relative to S-OLS and falls a little short of S-2SLS on unbiasedness grounds" (Franzese & Hays 2007, 163). In a follow-up paper, Hays et al. (2009) develop the *multiparametric spatiotemporal autoregressive* (m-STAR) model, which is estimated via S-ML, a maximum likelihood estimator that jointly estimates the exogenous, non-spatial, effects and temporal and spatial interdependence (the former via the introduction of the lagged dependent variable). In contrast to other spatial approaches, m-STAR allows for multiple contemporaneous spatial-weights matrices. In matrix notation (analogous to Hays et al. (2009, 21)),

$$\mathbf{y} = \rho_b\mathbf{W}^b\mathbf{y} + \rho_d\mathbf{W}^d\mathbf{y} + \phi\mathbf{M}\mathbf{y} + \mathbf{X}\beta + \varepsilon, \tag{4.2}$$

where $\mathbf{y}$, the dependent variable, is a $NT \times 1$ vector of basin-dyads stacked by years, ρ_b and ρ_d are the spatial-autoregressive coefficients on the basin- and dyad contiguity matrices, $\mathbf{M}$ is an $NT \times NT$ matrix with ones on the minor diagonal and zeros elsewhere ($\mathbf{My}$ is thus simply the lagged dependent variable) and ϕ its coefficient; $\mathbf{X}$ is a $NT \times k$ matrix containing the exogenous non-spatial variables described above and β its $k \times 1$ vector of coefficients, and ε is the $(NT \times 1)$ $i.i.d.$ error term. Hayes et al.'s Monte Carlo simulations show that, compared to OLS and S-OLS, the m-STAR model estimated with S-ML is "clearly dominant for all estimates and estimate-properties" (Hays et al. 2009, 25). That is, even for small T,[24] S-ML outperforms the other estimators.

[21] Rather than introducing binary spatial weights one might consider more sophisticated weights, such as giving more weight to dyads further up-stream or (in the case of many riparians) to those geographically or economically closer to the dyad in question. From an empirical point of view, I expect little insight by such (arbitrary) modification of weights given that in most cases events are either confined to one particular dyad (or basin) or they embrace all riparians.

[22] For an overview, see Elhorst (2003), Beck et al. (2006), Franzese & Hays (2007).

[23] spatial ordinary least squares (spatial OLS), spatial maximum likelihood (S-ML), spatial two stage least squares (S-2SLS)

[24] In the analysis at hand, $T = 11$; the Monte Carlo simulations rely on $T = 10$

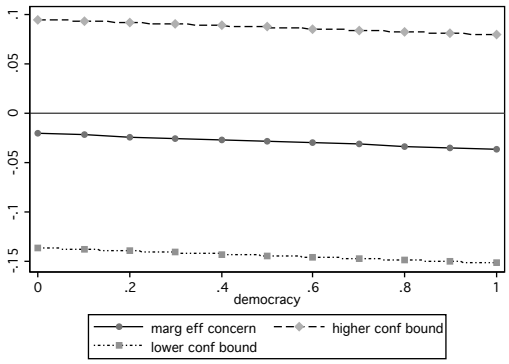

Figure 4.1: *H1, water quality subsample, marginal effect citizens' concern*

Whereas possible basin-specific unit effects are captured by time invariant basin characteristics (I estimated basin unit effects and regressed them on time-invariant basin characteristics to test this claim), I account for country-specific unit effects by introducing country fixed effects.

Given that m-STAR is not yet implemented in any statistical software package and the only code available relies on a maximisation routine that does not allow for missing values, I have linearly inter- and extrapolated the data whenever applicable and substituted other missing values by the variable's mean value.

4.4 Results

Beginning with hypothesis 1a, table 4.1 presents the results disaggregated by issue area. The results for the full sample of water quality (as outlined above, an example of a public good), as well as water quantity support the claim that democracies are better providers of public goods. As anticipated, we observe a positive, statistically significant influence of the size of the winning coalition on the cooperativeness of countries interaction in non-upstream-downstream basins. I added the size of the winning coalition squared to allow for a possible curvilinear effect. Apparently, the larger the winning coalition, the more cooperation takes place, but once a certain threshold is reached the effect dampens. As anticipated, results are less clear for joint management. Of the main explanatory variables, only the coefficient on the squared winning coalition is statistically significant.

Regarding the effect of citizens' concern on democratic leaders behaviour, column 2 of table 4.1 reports results on a subsample of 44 countries[25], exploring the effects of citizens' concern. Citizens' concern, proxied by the average emphasis parties put on the environment, does not exert a statistically significant effect on cooperative or conflictive events, nor do any other of the variables presented for this subsample. Figure 4.1 shows the marginal effect of citizens' concern given different levels of democracy, which is statistically insignificant for all values of democracy. The non-significance of the results may be partly due to the smaller sample. Further,

[25] The case selection is due to data availability. In particular I use the sample for which data is provided by (Cusack & Fuchs 2002).

Table 4.1: *H1 (democracy), H2 (interlinkages)*

	border demarcating				border crossing
	water quality		water quantity	joint management	
	full sample	subsample			
constant	-0.061	-0.767	0.105	-0.060	0.019
	(.112)	(.000)***	(.087)	(.000)***	(.000)***
lag dep var	-0.055	-0.865	-0.315	-0.017	0.726
	(.020)***	(.027)***	(.000)***	(.012)	(.000)***
winng coalit	0.141	-0.014	0.023	-0.057	-0.062
	(.000)***	(.126)	(.000)***	(.039)	(.000)***
winng coalit^2	-0.062	-0.021	-0.031	0.069	0.034
	(.001)***	(0.05)	(.000)***	(.041)*	(.000)***
basinsize upstream					0.024
					(.000)***
democracy*basinsize upstream					0.010
					(.000)***
# joint IGO	0.000	0.000	0.000	0.000	0.000
	(.000)*	(.000)	(.000)***	(.000)	(.000)***
trade dep	0.000	-2.018	0.001	0.000	0.000
	(.000)	(1.607)	(.000)***	(.000)	(.000)***
ln open	0.000	0.000	0.001	0.001	0.001
	(.001)	(.001)	(.000)***	(.001)	(.000)***
ln gdpc	0.003	0.001	-0.003	0.012	-0.001
	(.000)***	(.003)	(.000)***	(.004)***	(.000)***
diff ln gdpc	0.000	0.000	0.000	0.000	0.000
	(.000)	(.001)	(.000)***	(.001)	(.000)***
env commitments	0.000	0.000	0.000	0.000	0.000
	(.000)	(.000)	(.000)***	(.000)**	(.000)***
EU	-0.009	-0.005	-0.019	0.013	-0.050
	(.011)	(.007)	(.000)***	(.015)	(.000)***
gov owned source	0.197	0.249	0.178	0.243	0.073
	(.023)***	(.023)***	(.000)***	(.015)***	(.001)***
partly indep source	0.283	0.362	0.265	0.133	0.073
	(.028)***	(.020)***	(.000)***	(.020)***	(.000)***
affinity	0.059	-0.053	0.036	0.005	0.000
	(.000)***	(.045)	(.000)***	(.034)	(.000)***
ln gdp	0.006	-0.002	-0.001	0.003	0.001
	(.000)***	(.003)	(.000)***	(.004)	(.000)***
diff ln gdp	0.005	0.001	0.010	0.000	0.001
	(.000)***	(.002)	(.000)***	(.002)	(.000)***
green emphasis		-0.016			
		(.016)			
democracy*green emphasis		0.012			
		(.021)			
democracy*dependency ratio		-0.001			
		(.000)***			
dependency ratio		0.000			
		(.000)***			
basinsize	0.000	0.000	-0.098	0.000	0.195
	(.000)***	(.000)***	(.000)***	(.000)***	(.000)***
# riparians	0.020	0.006	0.001	0.009	0.001
	(.001)***	(.002)***	(.000)***	(.001)***	(.000)***
pop density	0.000	0.000	0.006	0.000	8.301
	(.000)**	(.000)***	(.000)***	(.000)***	(.000)***
scarcity	0.000	0.000	0.006	-0.077	-0.439
	(.000)***	(.000)	(.000)***	(.062)	(.000)***
mixed river	-0.023	-0.025	0.006	-0.039	
	(.005)***	(.010)**	(.000)***	(.050)	
rivers w/ mixed direction					0.005
					(.000)***
rivers w/ other direction					-0.002
					(.000)***
basin spat lag	0.055	0.171	0.854	0.035	-0.038
	(.049)***	(.042)	(.000)***	(.024)***	(.000)***
dyad spat lag	0.187	-0.156	-0.331	0.139	0.236
	(.027)***	(.037)***	(.000)***	(.019)***	(.000)***
σ	0.095	0.052	0.051	0.128	45.026
	(.000)***	(.000)***	(.000)***	(.000)***	(.000)***
N	3892	1175	3892	3892	7955

all regressions include country fixed effects
standard errors in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%

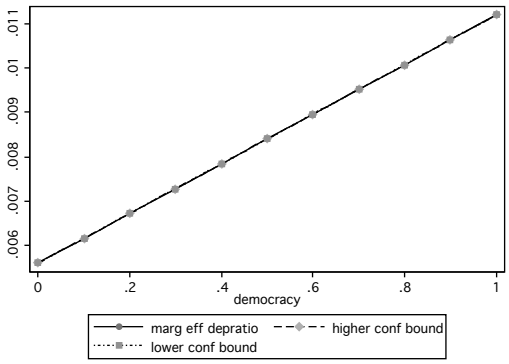

Figure 4.2: *H1, water quantity, marginal effect dependency ratio*

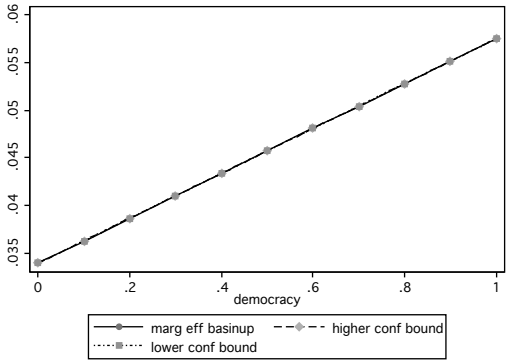

Figure 4.3: *Marginal effect basinsize for different levels of democracy*

given that the sample only consists of very similar countries in terms of their degree of development, infrastructure, political and economic integration, etc. there is rather little variation to be observed in the first place. For water quantity, I have proxied concern using a country's dependency ratio. The interaction effect is illustrated in figure 4.2 and clearly indicates a positive and statistically significant[26] effect of concern which rises with the level of democracy. Abstracting from the impact of citizen concern in the water quality subsample, we thus find general support for Hypothesis 1a.

Hypothesis 1b postulates the affectedness of upstream-countries to play a role in the degree to which they engage in cooperative or conflictive events. As shown in figure 4.3, the size of the basin in the upstream country (meant to proxy affectedness) is indeed positive and - as predicted - the effect is stronger for democracies than it is for autocracies.[27] Although the independent effect of democracy appears counter-intuitive, the last column of table 4.1 displays a negative coefficient for the winning coalition with the square term being positive, it should be noted that an independent interpretation of these coefficients is meaningless, since they refer to the case where the size of the basin upstream is zero. By definition of a border-crossing river, such hypothetical cases are non-existent.

[26] Note that the confidence interval is too small to be visible.
[27] Note that again the confidence interval is too small to be visible.

As to hypothesis 2 (interlinkages), for all of the three issues presented in table 4.1 (ignoring the water quality subsample), joint IGO membership positively affects cooperative behaviour, thus hinting at typical Kantian peace interdependency arguments applying. The effect of trade dependencies, however, is less clear. Whereas the coefficient is positive for all three issues (again ignoring the water quality subsample), it is only statistically significant for water quantity. Regarding upstream-downstream settings, we find both trade dependency and joint IGO membership to display the predicted positive effect on cooperation levels. We thus find strong support for hypothesis 2b and weak support for hypothesis 2a.

Table 4.2: *H3 (severity) by issue type*

	water quantity		Water Quality
	sev: withdrawal	sev: dep.ratio	
constant	-0.008	-0.008	-0.003
	(0.013)	(0.013)	(0.015)
lagged dep var	0.857	0.855	0.663
	(0.006)***	(0.006)***	(0.008)***
winng coalit	0.006	0.010	0.039
	(0.009)	(0.009)	(0.011)***
winng coalit^2	-0.024	-0.021	-0.009
	(0.009)***	(0.009)**	(0.011)
# joint IGO	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)
trade dep	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)***
ln trade openness	0.000	0.000	0.001
	(0.000)**	(0.000)**	(0.000)***
ln gdp/capita	-0.000	-0.001	-0.000
	(0.001)	(0.001)	(0.001)
ln gdp//cap diff	-0.000	-0.000	0.000
	(0.000)**	(0.000)*	(0.000)
env commitments	0.000	0.000	-0.000
	(0.000)***	(0.000)***	(0.000)
EU	-0.006	-0.007	0.002
	(0.003)**	(0.003)**	(0.004)
gov owned source	0.118	0.117	0.130
	(0.006)***	(0.006)***	(0.011)***
partly indep source	0.140	0.140	0.259
	(0.007)***	(0.007)***	(0.010)***
affinity	0.017	0.014	0.010
	(0.004)***	(0.004)***	(0.005)*
ln gdp	-0.001	-0.000	-0.002
	(0.001)	(0.001)	(0.001)*
difference in ln gdp	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)
basinsize	-0.000	-0.000	0.000
	(0.000)	(0.000)	(0.000)***
# riparians	0.000	0.000	0.002
	(0.000)	(0.000)	(0.000)***
total freshwater withdrawal (km3/yr)	-0.000	-0.000	
	(0.000)***	(0.000)***	
water dependency	0.000	0.000	
	(0.000)	(0.000)***	
pop density			0.000
			(0.000)
democracy*severity	0.000	-0.000	-0.000
	(0.000)***	(0.000)**	(0.000)
scarcity	0.000	0.000	
	(0.000)	(0.000)	
rivers w/ mixed direction	0.003	0.003	0.007
	(0.002)*	(0.002)*	(0.002)***
rivers w/ other direction	0.002	0.002	0.005
	(0.002)	(0.002)	(0.002)***
upstream downstream	-0.002	-0.002	-0.007
	(0.001)	(0.001)	(0.002)***
dyad spat lag	-0.017	-0.018	0.067
	(0.010)*	(0.010)*	(0.009)***
basin spat lag	0.126	0.125	0.582
	(0.013)***	(0.013)***	(0.010)***
σ	.06	.06	.06
	(0.000)***	(0.000)***	
N	11847	11847	11834

all regressions include country fixed effects
standard errors in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%

Regarding the effect of severity on countries' cooperation levels (H3), the results presented in

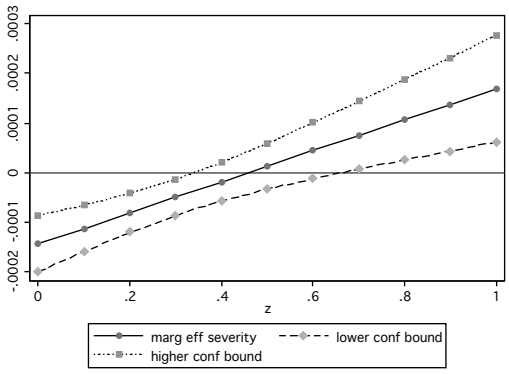

Figure 4.4: *Marginal effect severity (total withdrawal) for different levels of democracy*

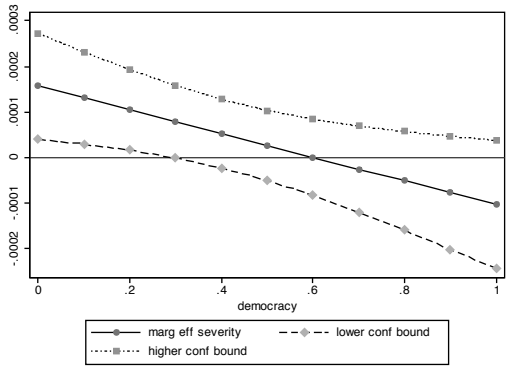

Figure 4.5: *Marginal effect severity (dependency ratio) for different levels of democracy*

table 4.2 show different effects depending on the severity indicator applied. This becomes especially apparent when considering figures 4.4 to 4.6 depicting the effect of salience for different levels of democracy. We observe clear support for H3 when operationalising severity by water withdrawal: the effect of severity is negative in autocracies and positive in democracies. The effect is reversed and statistically insignificant when severity is proxied by the dependency ratio, or – as in the case of water quality – with population density. In all three cases, the coefficients displayed in table 4.2 are rather small. With respect to water quality, the counter-intuitive result might however be largely driven by events taking place on the Nile and the Danube. Given that most events occur in these two basins, I have rerun all models excluding both the Nile and the Danube (section 4.4.1). Whereas most of the main results pertain, the interaction of democracy and salience in the case of water quality is reversed in sign and also becomes statistically significant. That is, the effect of severity is again negative for autocracies and positive for democracies. The marginal effect of severity in this case is plotted in figure 4.14.

As to hypothesis 4a, the first column of table 4.3 shows the effect of issue salience and its interaction with democracy on the level of cooperation in a river-sharing dyad. To facilitate interpretation, I have plotted the marginal effect of three categories of salience given different levels of democracy in figures 4.7 to 4.9. Compared to the baseline category of no salience, both low and medium salience have a positive impact on the level of cooperation. In contrast to the

Table 4.3: *H4 (salience) by basin type*

	border-demarcating	border-crossing
constant	-0.399	-0.152
	(0.079)***	(0.032)***
lagged dep var	0.408	0.697
	(0.011)***	(0.005)***
winng coalit	0.124	-0.033
	(0.039)***	(0.019)*
winng coalit^2	-0.050	0.001
	(0.041)	(0.020)
low salience	0.307	
	(0.012)***	
medium salience	0.375	
	(0.027)***	
high salience	0.229	
	(0.078)***	
low sal*democracy	-0.088	
	(0.023)***	
medium sal*democracy	-0.225	
	(0.046)***	
high sal*democracy	-0.233	
	(0.137)*	
recoded salience		0.225
		(0.006)***
recoded salience*dem		-0.067
		(0.010)***
# joint IGO	0.000	0.000
	(0.000)	(0.000)*
trade dep	0.000	-0.000
	(0.000)*	(0.000)
ln trade openness	0.001	0.001
	(0.001)	(0.000)**
ln gdp/cap	-0.004	-0.001
	(0.005)	(0.002)
difference in ln gdp/cap	-0.001	-0.001
	(0.001)	(0.000)*
env commitments	0.000	0.000
	(0.000)	(0.000)
EU	-0.009	-0.021
	(0.015)	(0.006)***
gov owned source	0.041	-0.040
	(0.014)***	(0.007)***
partly indep source	0.034	-0.044
	(0.018)*	(0.007)***
affinity	0.057	-0.008
	(0.033)*	(0.011)
ln gdp	0.000	0.002
	(0.004)	(0.002)
diff in ln gdp	0.002	0.001
	(0.002)	(0.001)
basinsize	-0.000	0.000
	(0.000)	(0.000)
# riparians	0.011	-0.000
	(0.001)***	(0.000)
pop density	-0.000	
	(0.000)*	
scarcity	-0.000	0.000
	(0.000)	(0.000)***
mixed river	-0.015	-0.000
	(0.007)**	(0.000)***
dyad spat lag	0.025	-0.018
	(0.016)	(0.008)**
basin spat lag	0.332	0.138
	(0.016)***	(0.008)***
basinsize upstream		0.000
		(0.000)***
rivers w/ mixed direction		0.003
		(0.003)
rivers w/ other direction		-0.000
		(0.003)
σ	.13	.08
	(0.000)***	(0.000)***
N	3892	7954

all regressions include country fixed effects
standard errors in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%

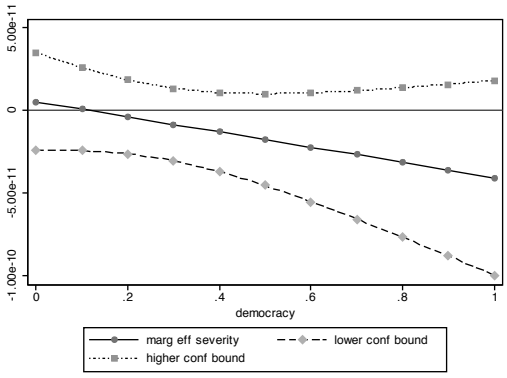

Figure 4.6: *Marginal effect severity (population density) for different levels of democracy*

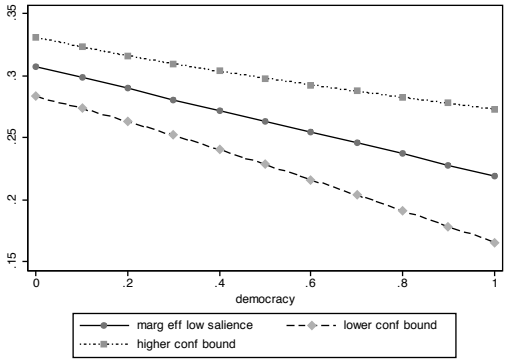

Figure 4.7: *Marginal effect low salience for different levels of democracy*

theoretical expectation, this effect is more pronounced in autocracies than it is in democracies. These results are robust to excluding the Nile and the Danube. We observe a similar picture for high levels of salience, although in this case, the effect becomes insignificant for larger winning coalitions (higher than .6). For high salience, the effect becomes independent of democracy once the Nile and Danube are excluded.

Turning to hypothesis 4b, there is a clear positive effect of the transformed salience measure. This lends support to the hypothesis that in upstream-downstream settings, governments resort to more extreme actions in terms of their cooperativeness and conflictiveness when salience is high. Interestingly, as we can see in figure 4.10, the effect is stronger for autocracies than it is for democracies. That is, the marginal effect of the transformed salience measure is positive for all levels of autocracy/ democracy, but higher the smaller the winning coalition. This means that the measures autocracies take in the case of salient upstream-downstream issues are even more extreme than those taken by democracies. This effect pertains independently of whether or not the Nile and Danube basins are included in the sample and is also consistent with different specifications of the dependent variable.

Regarding country-specific control variables, both GDP per capita and GDP as such show the expected positive coefficient for both water quality and joint management in border-demarcating rivers (table 4.1), but a negative one for water quantity. Considering border-crossing rivers, the

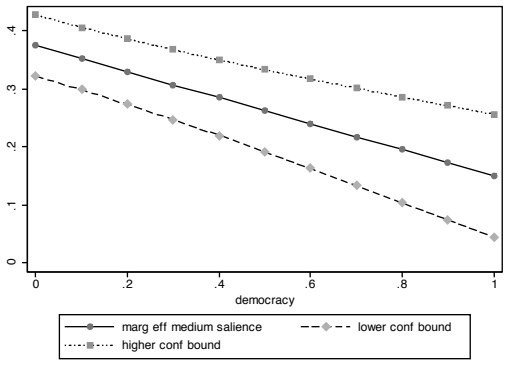

Figure 4.8: *Marginal effect medium salience for different levels of democracy*

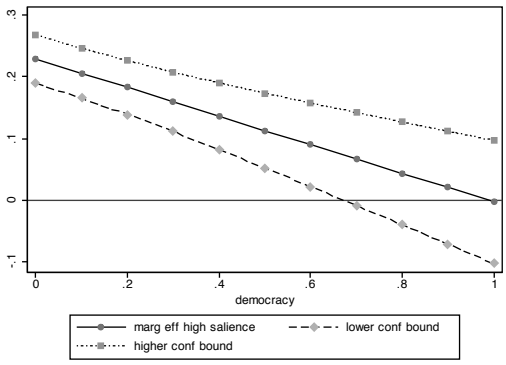

Figure 4.9: *Marginal effect high salience for different levels of democracy*

coefficient on GDP is again positive, but the one on GDP per capita is negative (and statistically significant). When considering all types of rivers (table 4.2), the coefficients on both GDP and GDP per capita are statistically insignificant, thus putting in question whether capacities have an impact on cooperativeness. The difference in GDP in a dyad – that is, power asymmetries – exhibits a predominantly positive coefficient. This is in line with Kantian peace arguments that consider balance of power an important aspect of peaceful dyadic relationships (cf. Singer et al. 1972, Russett & Oneal 2001). The results further indicate that - compared to the independent base category - both government owned and partly independent sources are related to more cooperative events across issues and for both border-demarcating and border-crossing rivers. This result might imply that countries with less free media over-report cooperative events. However, this result does not appear to dilute the democracy effect, given that the coefficient on the latter is still positive (ignoring the insignificant effects for both the subsample and joint management in border-demarcating rivers). Trade openness shows the expected positive impact on cooperation, but only statistically significantly so in the case of water quantity and for border-crossing rivers in general. Affinity is predominantly positive, and statistically significantly so for both water quality and water quantity in border-demarcating rivers and across issues in the case of border-crossing rivers, but insignificant and negative for the water quality subsample. Whereas the coefficient on ratification of environmental treaties is positive across issues (although only statistically significantly so for water quantity and joint management and in the case of border-crossing rivers), the results regarding the EU membership dummy are rather mixed.

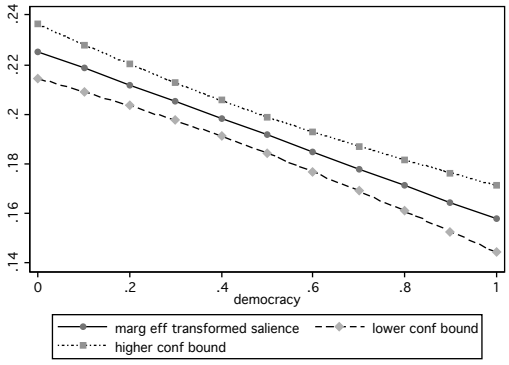

Figure 4.10: *Marginal effect transformed salience for different levels of democracy*

With respect to basin-specific control variables, we observe predominantly positive coefficients. With the basinsize, the number of riparians and population density in a basin all being positive and highly statistically significant, the expectation that more important basins invoke more intergovernmental cooperation is supported. In line with Hamner (2009), scarcity exhibits a positive effect for both water quality and water quantity in border-demarcating rivers, but is negative and statistically insignificant for joint management and negative and statistically significant in the case of upstream-downstream settings. In line with the theoretical distinction between public goods and common pool goods, we observe less cooperation in mixed rivers when it comes to water quality and more cooperation in the case of water quantity. Furthermore, we see an ambiguous effect of sharing other rivers with the opposite flow direction when it comes to weakening power asymmetries in border-crossing rivers: whereas sharing "mixed" rivers leads to more cooperation, sharing other rivers with clear up- and downstream countries is predicted to lead to less cooperation.

As to the interdependencies, basin spatial lags are estimated to be positive and statistically significant for all issues in border-demarcating rivers. The coefficient on the basin spatial lag for border-crossing rivers, however, is statistically significant and negative. The coefficient on the dyad spatial lag differs across issue types and geographical settings. It is positive and statistically significant for water quality and quantity in border demarcating rivers, for border-crossing rivers in general, and statistically insignificant for the entire sample when testing for the effect of salience (table 4.2). Table 4.4 exemplarily[28] shows the estimated interdependence on interactions in border-crossing rivers in 2006 (i.e. $\hat{W} = \hat{\rho}_b \mathbf{W}^b \mathbf{y} + \hat{\rho}_d \mathbf{W}^d$) for some selected country-basins. Starting in the first row and column, we see that the behaviour of Canada and the USA who are not linked to any of the other countries shown via common basins is independent of the other dyad-basin pairs shown in the table (all entries are zero). However, the behaviour of Russia and Finland on the Kerni is (negatively) linked to the behaviour of Finland and Norway on the same basin (second row, third column). Moving further right, the following block of non-zero cell entries indicates interdependencies among Ob/Irtysh riparians. All these results refer to basin spillover effects. Dyadic interdependencies are imminent in several cases: for instance the

[28] Reporting all estimated weights for all models (and (sub-)samples) estimated would probably lead to more confusion than insights. I have therefore chosen to exemplarily highlight some interdependency effects. Other estimated weights matrices are available upon request. The same applies for steady states.

Table 4.4: *Estimated Interdependence border crossing rivers in 2006, selected country-basins*

country1	country2	basinname	USA Canada Firth	Russia Finland Kemi	Finland Norway Kemi	Russia Kazakh. Ob/Irtysh	Russia China Ob/Irtysh	Russia Mongolia Ob/Irtysh	Kazakh. China Ob/Irtysh	China Mongolia Ob/Irtysh	Russia Belarus Volga	Russia Kazakh. Volga	Belarus Kazakh. Volga	Russia Kazakh. Oral/Ural	Russia Kazakh. Pu Lun T'o	Russia China Pu Lun T'o	Kazakh. Mongolia Pu Lun T'o	China Mongolia Pu Lun T'o	Tajik. China Aral Sea	Uzbek. Kazakh. Aral Sea
USA	Canada	Firth	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Russia	Finland	Kemi	0	0	.00181*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Finland	Norway	Kemi	0	.00181*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Russia	Kazakhstan	Ob/Irtysh	0	0	0	0	.00070*	.00070*	.00070*	.00070*	0	.00550*	0	.00550*	.00550*	0	0	0	0	0
Russia	China	Ob/Irtysh	0	0	0	.00070*	0	.00070*	.00070*	.00070*	0	0	0	0	0	.00438*	0	0	0	0
Russia	Mongolia	Ob/Irtysh	0	0	0	.00070*	.00070*	0	.00070*	.00070*	0	0	0	0	0	0	0	0	0	0
Kazakhstan	China	Ob/Irtysh	0	0	0	.00070*	.00070*	.00070*	0	.00070*	0	0	0	0	0	0	0	0	0	0
China	Mongolia	Ob/Irtysh	0	0	0	.00070*	.00070*	.00070*	.00070*	0	0	0	0	0	0	0	0	.00550*	0	0
Russia	Belarus	Volga	0	0	0	0	0	0	0	0	0	.00119*	.00119*	0	0	0	0	0	0	0
Russia	Kazakhstan	Volga	0	0	0	.00550*	0	0	0	0	.00119*	0	.00119*	.00550*	.00550*	0	0	0	0	0
Belarus	Kazakhstan	Volga	0	0	0	0	0	0	0	0	.00119*	.00119*	0	0	0	0	0	0	0	0
Russia	Kazakhstan	Oral/Ural	0	0	0	.00550*	0	0	0	0	0	.00550*	0	0	.00550*	0	0	0	0	0
Russia	Kazakhstan	Pu Lun T'o	0	0	0	.00550*	0	0	0	0	0	.00550*	0	.00550*	0	.00058*	.00058*	.00058*	0	0
Russia	China	Pu Lun T'o	0	0	0	0	.00438*	0	0	0	0	0	0	0	.00058*	0	.00058*	.00058*	0	0
Kazakhstan	Mongolia	Pu Lun T'o	0	0	0	0	0	0	0	0	0	0	0	0	.00058*	.00058*	0	.00058*	0	0
China	Mongolia	Pu Lun T'o	0	0	0	0	0	0	0	.00550*	0	0	0	0	.00058*	.00058*	.00058*	0	0	0
Tajikistan	China	Aral Sea	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	.00016*
Uzbekistan	Kazakhstan	Aral Sea	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	.00016*	0

All estimated weights marked with * statistically significant ($p \leq .01$).

behaviour of Russia and Kazakhstan on the Ob/Irtysh is positively related to the same country pairs behaviour on the Volga or the Oral. All non-zero entries of the interdependency matrix presented in table 4.4 are statistically significant.

Another example is given in table 4.5. We observe that, for instance, the behaviour of the Central African Republic and Tanzania (or Uganda and Rwanda) towards the Congo is positively related to their behaviour towards the Nile. Similar patterns apply for Tanzania and Zambia on the Zambezi and the Congo basin. Table 4.5 further indicates positive interdependencies within basins. For example, the behaviour of the Central African Republic and Tanzania on the Congo is positively related to the one of other riparians. However, these links are not statistically significant.

Given that the regression coefficients in tables 4.1 to 4.3 only show the pre-dynamic impetuses (Hays et al. 2009, 13), I have calculated steady-state spatiotemporal effects and estimated the long-run-effects of hypothetical permanent shocks for selected samples and counterfactuals. For the model at hand, the long-run steady state is obtained by recursively solving expression 4.2:

$$\begin{aligned} \mathbf{y_t} &= \rho_b \mathbf{W}^b \mathbf{y_t} + \rho_\mathbf{d} \mathbf{W^d} \mathbf{y_t} + \phi \mathbf{y_{t-1}} + \mathbf{X_t}\beta + \varepsilon_\mathbf{t}, \\ &= \left[\mathbf{I_N} - \rho_\mathbf{b} \mathbf{W^b} - \rho_\mathbf{d} \mathbf{W^d} - \phi \mathbf{I_N}\right]^{-1} (\mathbf{X_t}\beta + \varepsilon_\mathbf{t}), \end{aligned}$$

where I again follow the notation in Hays et al. (2009) and adjust their equations[29] to the analysis at hand.

Table 4.6 illustrates the effect of a hypothetical increase in the bounded cooperation score (on water quality) of Tanzania and Zambia on the Congo basin in 2004 of .5,[30] where all other variables (and the spatial weights) are held at their 2004 levels. To enhance readability, table 4.6 only shows the effects on selected basin-dyads (the same as those presented in table 4.5). Starting with the first row, we observe that for basin-dyads that are obviously not linked to the "shocked" basin-dyad (neither via co-riparianship, nor co-dyadship), the post-shock steady state is estimated to be exactly equivalent to the pre-shock steady state. For dyads such as Uganda and Rwanda on the Congo basin, in contrast, the post-shock steady state is greater than the pre-shock steady state due to the fact that this dyad is linked to Tanzania and Zambia via the Congo basin. Indirect interdependencies become apparent when considering the difference in pre- and post-shock steady states for Zambezi riparians: the effect on Tanzania and Zambia in this basin is obviously the largest, but even country pairs not including either of the "shocked" countries, such as Malawi and Angola, experience an upward shift in the steady-state level of cooperation through indirect ties. The network effects go as far as inducing higher post-shock steady states for basins on which only one of the shocked country is riparian and thus interacting with other countries, such as Tanzania and Mozambique on the Ruvuma basin. Finally, we can see

[29] Apart from the homophily term not included in this analysis, Hays et al. (2009) omit the ρ coefficients in equation (37), page 28.

[30] given the transformation of the dependent variable, such a shock would occur if a very cooperative event happened this period.

Table 4.5: *Estimated interdependence in 2004 (water quality), selected countries and basins*

country1	country2	basin	Finland Norway Tana	Central-African-Republic Tanzania Nile	Uganda Rwanda Nile	Central-African-Republic Tanzania Congo	Uganda Rwanda Congo	Tanzania Zambia Congo	Tanzania Namibia Congo	Zambia Zimbabwe Congo	Zambia Namibia Congo	Malawi Namibia Congo	Malawi Botswana Congo	Namibia Botswana Congo	Tanzania Zambia Zambezi	Tanzania Namibia Zambezi	Zambia Zimbabwe Zambezi	Zambia Namibia Zambezi	Malawi Namibia Zambezi	Tanzania Mozambique Ruvuma
Finland	Norway	Tana	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Central-African-Republic	Tanzania	Nile	0	0	0.00017	0.00888*	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Uganda	Rwanda	Nile	0	0.00017	0	0	0.00888*	0	0	0	0	0	0	0	0	0	0	0	0	0
Central-African-Republic	Tanzania	Congo	0	0.00888*	0	0	0.00009	0.00009	0.00009	0.00009	0.00009	0.00009	0.00009	0.00009	0	0	0	0	0	0
Uganda	Rwanda	Congo	0	0	0.00888*	0.00009	0	0.00009	0.00009	0.00009	0.00009	0.00009	0.00009	0.00009	0	0	0	0	0	0
Tanzania	Zambia	Congo	0	0	0	0.00009	0.00009	0	0.00009	0.00009	0.00009	0.00009	0.00009	0.00009	0.00888*	0	0	0	0	0
Tanzania	Namibia	Congo	0	0	0	0.00009	0.00009	0.00009	0	0.00009	0.00009	0.00009	0.00009	0.00009	0	0.01696*	0	0	0	0
Zambia	Zimbabwe	Congo	0	0	0	0.00009	0.00009	0.00009	0.00009	0	0.00009	0.00009	0.00009	0.00009	0	0	0.01696*	0	0	0
Zambia	Namibia	Congo	0	0	0	0.00009	0.00009	0.00009	0.00009	0.00009	0	0.00009	0.00009	0.00009	0	0	0	0.01696*	0	0
Malawi	Namibia	Congo	0	0	0	0.00009	0.00009	0.00009	0.00009	0.00009	0.00009	0	0.00009	0.00009	0	0	0	0	0.01696*	0
Malawi	Botswana	Congo	0	0	0	0.00009	0.00009	0.00009	0.00009	0.00009	0.00009	0.00009	0	0.00009	0	0	0	0	0	0
Tanzania	Zambia	Zambezi	0	0	0	0	0	0.00888*	0	0	0	0	0	0	0	0.00025	0.00025	0.00025	0.00025	0
Tanzania	Namibia	Zambezi	0	0	0	0	0	0	0.01696*	0	0	0	0	0	0.00025	0	0.00025	0.00025	0.00025	0
Zambia	Zimbabwe	Zambezi	0	0	0	0	0	0	0	0.01696*	0	0	0	0	0.00025	0.00025	0	0.00025	0.00025	0
Zambia	Namibia	Zambezi	0	0	0	0	0	0	0	0	0.01696*	0	0	0	0.00025	0.00025	0.00025	0	0.00025	0
Malawi	Namibia	Zambezi	0	0	0	0	0	0	0	0	0	0.01696*	0	0	0.00025	0.00025	0.00025	0.00025	0	0
Tanzania	Mozambique	Ruvuma	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

All estimated weights marked with * statistically significant ($p \leq 0.01$).

Table 4.6: *Steady State, water quality*

country1	**country2**	**basin**	**pre-shock steady state**	**post-shock steady state**	**difference**
Finland	Norway	Tana	-0.002849	-0.002849	0
Central African Republic	Tanzania	Nile	-0.033369	-0.033368	0
Uganda	Rwanda	Nile	-0.002216	-0.002216	0
Central African Republic	Tanzania	Congo	0.113650	0.113690	0.000040
Uganda	Rwanda	Congo	0.144810	0.144850	0.000040
Tanzania	Zambia	Congo	0.206680	0.680520	0.473830
Tanzania	Namibia	Congo	0.254660	0.254700	0.000040
Zambia	Zimbabwe	Congo	0.280900	0.280940	0.000040
Zambia	Namibia	Congo	0.327060	0.327100	0.000040
Malawi	Namibia	Congo	0.315120	0.315160	0.000040
Malawi	Botswana	Congo	0.307800	0.307840	0.000040
Tanzania	Zambia	Zambezi	0.034766	0.038754	0.003988
Tanzania	Namibia	Zambezi	0.105070	0.105070	0.000002
Zambia	Zimbabwe	Zambezi	0.152340	0.152350	0.000002
Zambia	Namibia	Zambezi	0.198500	0.198500	0.000002
Malawi	Namibia	Zambezi	0.349440	0.349440	0.000002
Tanzania	Mozambique	Ruvuma	0.023569	0.023570	0.000001

.5 shock to Tanzania Zambia Congo in 2004

that the effect of the shock to Tanzania and Zambia on the Congo is slightly mitigated through feedbacks within the network: although the shock itself was of .5 in magnitude, the post-shock steady state is .47 higher than the pre-shock steady state.

4.4.1 Robustness Checks

I have checked the robustness of the results presented in the previous section in various ways. These additional results are presented in tables 4.9 to 4.18 in the appendix.[31] In order to track whether the effect of democracy depends on its operationalisation, I have used the polity IV score and its squared term, instead of Bueno de Mesquita's W. Whereas many of the other results pertain, the coefficients on democracy and it's squared term become statistically insignificant and reverse sign for some samples.

In addition, one might claim that the transformation of the dependent variable along the lines of Crescenzi & Enterline (2001) might drive certain results. I have therefore rerun all models including a) a moving average of conflict- and cooperation intensities, b) exponential smoothing, and c) the "raw" conflict and cooperation score rather than the current transformation. Again, most of the results pertain, although trade dependency for water quantity in the whole sample (table 4.2) becomes statistically significant when using exponential smoothing and several basin-specific coefficients change for the same specification regarding water quantity.

Given that a very high fraction of all events coded actually pertain to either the Nile or Danube basins, I have rerun the models excluding these two basins. With respect to water quality in the whole sample (table 4.2), the coefficients on basinsize, population density and the democracy severity interaction change sign. It thus appears that the former results were driven by these two large basins rather than applying to the entire sample. Further, the effect of democracy becomes insignificant in the case of border-crossing rivers. The interaction of the upstream country's affectedness and its democracy score, however, qualitatively stays the same, such that the result of interest does not change. For the remaining specifications, no substantial change is observed when dropping these two basins.

4.5 Conclusion

The aim of this paper is to empirically analyse Kantian peace arguments, namely the context dependency of cooperation and conflict over shared resources. In particular, I highlight the impact of democracy and interlinkages on the degree of cooperativeness/conflictiveness of country

[31] In addition to the presented results, I have used indirect rather than direct trade and IGO links. There is no substantial change in any of the models presented. Also, the inclusion of dyadic FDI measures does not change the main results and the coefficient on FDI as such is statistically insignificant throughout all model specifications, (sub-)samples and issues under consideration, which is why these results are not presented in detail. Finally, I assessed the impact of a dyad being in an ongoing military dispute. Data are taken from the UCDP Dyadic Dataset (Harbom et al. 2008). For the given time period, there hardly exist any inter- or intra-state conflicts. I have therefore chosen not to include the variable in the models presented here.

pairs interactions over shared water resources taking into account geography, salience, and cost-benefit considerations.

The empirical results show that the hypothesised positive effect of democracy holds, although the relationship between democracy and cooperation over shared resources appears to be non-linear. That is, the positive relationship between democracy and cooperation is only observed until a certain threshold is reached, whereupon the effect is dampened. Future research should examine this relationship more closely and assess the effect of alternative operationalisations, such as the age of democracy (the number of years since a country has become democratic), because there might be a qualitative difference between younger and more mature democracies, i.e. democratic norms might be more prominent in more mature democracies.

Political interlinkages proxied by joint IGO membership positively affect a country pairs' relationship in terms of cooperation over joint freshwater resources, thus lending support to classical Kantian peace arguments.

In the theoretical framework, I argue that different context factors play a role in explaining the relationship between regime type (democracy versus autocracy) and cooperation over shared resources, these include problem characteristics such as the salience and the severity of transboundary environmental problems. On the one hand, severity increases abatement costs and thus reduces governments' incentives to react. On the other hand, salience might encourage democratic governments to take action in order to avoid electoral punishment. Both concepts were expected to be highly correlated in democratic regimes, where citizens have easy access to information and thus become aware of environmental problems. In autocratic regimes, in contrast, even very severe environmental problems might not be afflicted with salience, since citizens are simply not informed about the issue. In addition, even if public awareness were high, autocratic leaders have less incentives to respond to their citizens' demands, since these politicians are relatively independent of their citizens' loyalty. Consequently, autocratic governments are expected to be reluctant to react to severe problems, whereas democratic leaders are expected to take action as long as the salience of the problem is high. The results on severity largely hinge on the indicator used for severity. Whereas using water withdrawal to proxy water shortages and hence severity renders results that are in-line with the theoretical expectations, water dependency and population density yield less clear results. A potential challenge for further research thus lies in the extension of data collection on so as to include more adequate proxies for severity. There is a clear link between issue salience and cooperation/conflict over shared water resources. As expected, cooperation levels are higher in border-demarcating rivers when salience is high and action becomes more extreme (both in terms of cooperation and conflict) in upstream-downstream basins. Counter to my expectation, the effect of salience is more extreme in autocracies than it is in democracies.

Geographic context factors clearly play an important role in understanding cooperation over shared resources. For instance the interaction of regime type and the affectedness of upstream countries is crucial in explaining cooperation levels in upstream-downstream settings. High affectedness leads to more cooperation with the effect being stronger for democracies than for autocracies. It thus appears that context dependency is important, although some empirical re-

sults cut against the theoretical expectations. In other words, the results support the expectation that Kantian peace arguments are applicable in the context of shared resources, but the effect of democracy and interlinkages varies with context factors such as geography.

The results of this paper imply that – so far– there is no empirical support for the water war hypothesis. In contrast, cooperation outweighs conflict, but the nature and degree of cooperation varies both within and across countries and basins. The most robust predictor for cooperation levels is the joint membership in international organisations. With respect to policy implications, successful strategies for joint management should thus consider riparians political ties and not merely focus on basin characteristics.

4.6 Appendix

4.6.1 Data Sources

Table 4.7: *Independent and Control Variables*

	Variable	Description	Source
H1	winng coalit	size of winning coalition	Bueno de Mesquita: The Logic of Political Survival Data Source; recoded using polity data by Gleditsch (2008)
	democr	polity IV	Marshall & Jaggers (2002), Gleditsch (2008)
H2	# joint IGO	# joint membership in IGOs	Pevehouse et al. (2004)
	3rd IGO	3rd party IGO links	Dorussen & Ward (2008)
	trade dep	dyadic trade dependency (ratio of the sum of exports and imports of country *i* with country *j* to the total sum of exports and imports of country *i*)	Gleditsch (2006), Heston et al. (2006)
	3rd trade	3rd party trade links	Dorussen & Ward (2005)
H3	severity	population density in basin area	LandScan `http://www.ornl.gov/sci/landscan/`
		scarcity (basin-level)	based on Mitchell (2004)
		dependency ratio	Gleick (1998–2009)
		total water withdrawal	Gleick (1998–2009)
H4	salience low salience, medium salience, high salience, recoded salience	salience of river issue	own coding
Control Variables			
	ln trade openness	log of trade openness, ratio of exports+imports to gdp	Gleditsch (2006); Heston (2006)
	ln gdp/capita	log of GDP/ capita	Heston (2006)
	EU	EU membership	`www.europa.eu.int`
	env commitments	ratification of multilateral environmental agreements	(Mitchell 2002-2008*b*), CIESIN: `http://sedac.ciesin.columbia.edu/entri/`
	gov owned source, partly indep source	neutrality of the media source (if unavailable: press freedom in country that issued media article)	World News Connection: `http://wnc.fedworld.gov/`, Freedomhouse: `http://www.freedomhouse.org/`
	affinity	similarity of UN voting patterns in dyad	Gartzke and Jo (2002)
	basin type	border-crossing, border demarcating basin	Toset et al. (2000)
	basin size	size of basin in each country	Toset et al. (2000)

4.6.2 Data Illustrations

In the following, I briefly illustrate the data used for constructing the dependent variable.

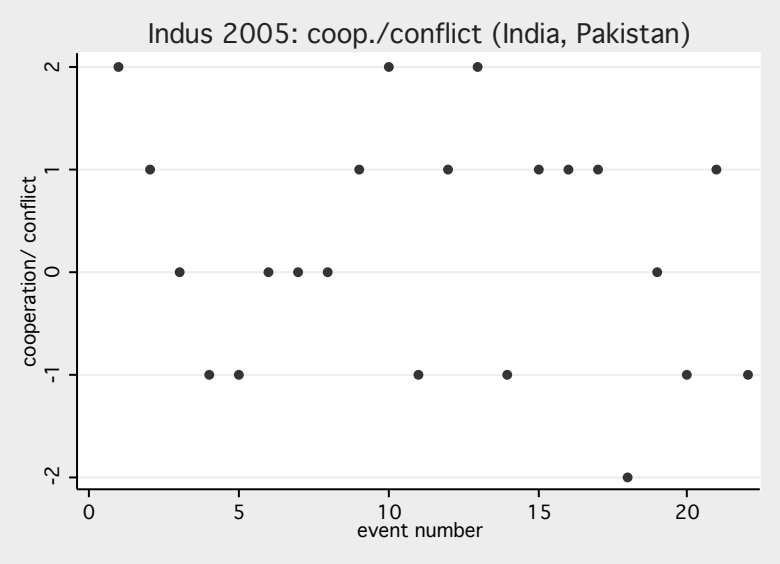

Figure 4.11: *Indus 2005, cooperation conflict score India Pakistan*

Figure 4.11 shows the cooperativeness/ conflictiveness of interactions between India and Pakistan in 2005 regarding the Indus basin. We observe quite some variation in terms of the degree of cooperativeness/ conflictiveness. Looking at the event descriptions in table 4.8 reveals that basically all of these interactions refer to an Indian dam project disliked by Pakistan authorities. The information displayed in table 4.8 is meant to illustrate how the event data described in section 4.3.1.1 is coded.

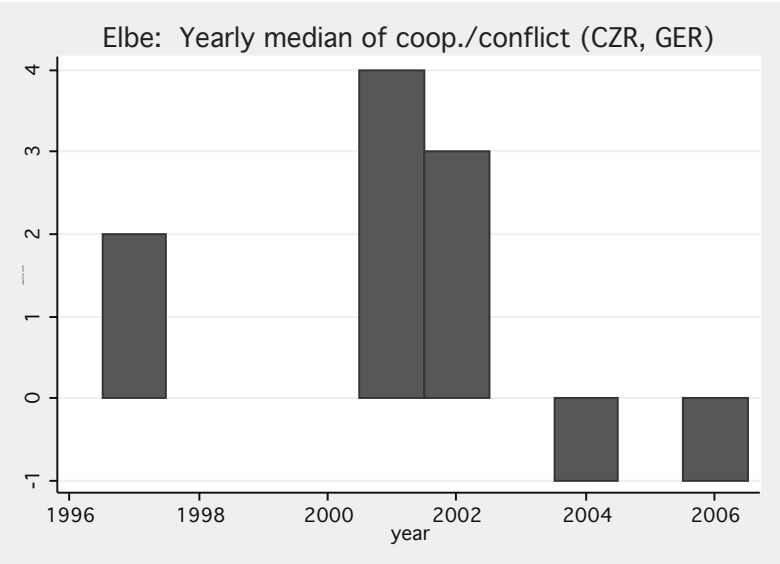

Figure 4.12: *Elbe, median cooperation conflict scores Germany, Czech Republic*

Whereas figure 4.11 illustrates the degree of cooperation and conflict of different events in a

Table 4.8: *Cooperative/ Conflictive events between India and Pakistan, Indus, 2005*

date	event	category	coop/ confl
8/5/2005	India was ready to redesign the Kishanganga hydro power project to obviate Pakistan's reservations.	expressing willingness to come to an agreement	2
11/5/2005	Indian water officials held three-day talks with their Pakistani counterparts to iron out differences over Kishenganga hydro power project in Jammu and Kashmir, but failed to achieve a major breakthrough.	visit by lower officials for talks on joint water issues	1
11/5/2005	Shah said: "Pakistan will not become a party to delay the resolution of Kishanganga dam issue. If India is interested in lingering on the issue, they should suspend the construction work first. We will be ready to hold talks continuously till the final resolution"	rhetorical statements	0
12/5/2005	Talks on the Kishanganga dam project have failed	failure to come to reach agreement in dispute settlement attempt	-1
12/5/2005	India has refused to stop work on the project, although both countries have declared they will continue their dialogue	refusing to accept compromise/ solution to dispute proposed by other country	-1
12/5/2005	We say our government should talk to India	rhetorical statements	0
12/5/2005	We say both countries should move ahead towards a mutual resolution of the problems in order to open ways for development	rhetorical statements	0
12/5/2005	""It is the need of the hour that India should abide by the Indus Basin Treaty and give due importance to Pakistan's standpoint so that the issue can be settled down by consensus"	rhetorical statements	0
1/6/2005	Indian and Pakistani water officials have begun talks on the Kishenganga water project in New Delhi	meeting of high officials discussing joint water issues	1
1/6/2005	India's water commissioner says that they have another two days to discuss each and every issue comprehensively and that the objective of the Kishenganga project is to arrive at a design which is acceptable to both the sides	expressing willingness to come to an agreement	2
1/6/2005	Pakistan's Indus Water Commissioner says that they have uses downstream of this river and that if water is diverted, their uses will be harmed	mild verbal expressions displaying discord in interaction	-1
2/6/2005	Talks between India and Pakistan to resolve differences on the Kishenganga hydro-power project remained inconclusive.	minor official exchanges, talks or policy expressions	1
29/6/2005	India and Pakistan reported "tangible and good progress" and "better understanding" at the secretary-level talks on Wullar Barrage-Tulbul Navigation Project in Jammu and Kashmir and agreed to continue discussions to resolve the differences on it	expressing willingness to come to an agreement	2
6/7/2005	Pakistan has asked India to stop work on the Wullar Barrage because it is a violation of the Indus Waters Treaty	proposing unwanted dam or other flow regulation	-1
8/8/2005	Pakistani experts visit site of Kishanganga Dam project which Islamabad believes may breach Indus Water Treaty	visit by lower officials for talks on joint water issues	1
8/8/2005	talks in New Delhi	meeting of high officials discussing joint water issues	1
9/8/2005	Pakistan-India talks begin in New Delhi on Kishanganga Dam project which Islamabad believes may breach Indus Water Treaty	meeting of high officials discussing joint water issues	1
13/8/2005	Pakistan Indus Basin Commission member Siddiqi said that official talks between India and Pakistan at the Indus Basin Commission level could be considered as having failed because India had not been ready to follow the Indus Basin Treaty for the past 12 years	making threatening demands and accusations	-2
13/8/2005	Talking about Pakistan's repose over the Indian wish to divert Neelum River, Siddiqi said India could not divert Neelum River at any point under the Indus Basin Treaty	rhetorical statements	0
13/8/2005	Failure of dialogue between the Indian and Pakistani Indus Basin Commissions is not a new issue, as a three-day meeting between the Indus Basin commissioners of both countries to resolve Pakistan's objections over the Kishanganga project had already ended without any conclusion on 10 May, 2005, because Indian authorities had failed to provide relevant information	failure to come to reach agreement in dispute settlement attempt	-1
13/8/2005	Pakistani Indus Basin Commissioner Ali Shah is still in New Delhi to sign a joint declaration over the dialogue process between both countries	meeting of high officials discussing joint water issues	1
14/8/2005	Pakistan has formally announced that talks with India on the Kishanganga dam project under the Indus Basin Treaty have failed	failure to come to reach agreement in dispute settlement attempt	-1

single year, figure 4.12 shows yearly aggregated data for the interaction between Germany and the Czech Republic over the entire period of investigation. Apart from some conflictive events in 2004 and 2006, respectively (unwanted dam projects and cyanide pollution), interactions between the two countries are very cooperative. For instance, in 2001, Germany gave a considerable amount of money for the construction of a sewage pipeline and a central sewage station in the Czech Republic (this event drives the height of the bar in the middle of figure 4.12).

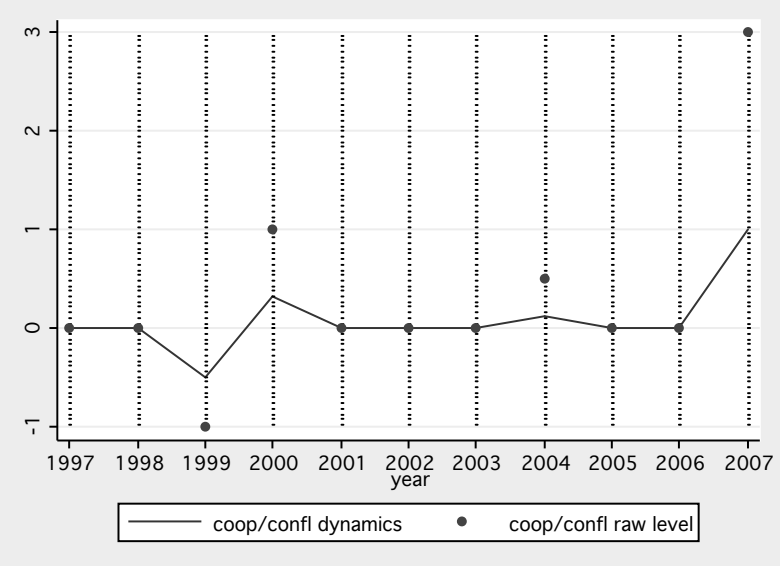

Figure 4.13: *Interaction Hungary Croatia, Drava*

Figure 4.13 shows the raw cooperation/conflict scores (dots) and the measure of the degree of cooperation/conflict in interstate relationship after applying transformation 4.1 (line) for the interactions between Hungary and Croatia on the Drava. We observe that both the conflictive and the cooperative events in 1999 and 2000 only slightly perturb the perceived relationships between the two countries, given that, previously, their interactions were rather neutral. Even the very positive event in 2007 (score of 3) only leads to an increase of the interaction level to 1, given the long neutral history.

4.6.3 Robustness Checks

Table 4.9: *Robustness Checks H1 & H2, water quality, border-demarcating rivers*

	original	polity	MA	exp smooth	raw	w/out Nile,Danube
constant	-0.311	-0.300	-0.737	2.195	-0.350	-0.346
	(0.062)***	(0.062)***	(0.284)***	(0.125)***	(0.326)	(0.078)***
lagged dep var	0.479	0.482	0.048	0.610	-1.385	0.387
	(0.018)***	(0.018)***	(0.083)	(0.035)***	(0.096)***	(0.023)***
winng coalit	0.119		0.588	0.076	0.628	0.156
	(0.024)***		(0.109)***	(0.043)*	(0.126)***	(0.034)***
winng coalit^{2}2	-0.066		-0.494	-0.059	-0.535	-0.091
	(0.025)***		(0.116)***	(0.045)	(0.133)***	(0.041)**
democr		-0.000				
		(0.002)				
dem^2		0.000				
		(0.000)				
# joint IGO	0.000	0.000	0.001	0.000	0.001	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.000)
trade dep	0.000	0.000	0.000	-0.000	0.000	0.000
	(0.000)***	(0.000)***	(0.000)***	(0.000)***	(0.000)***	(0.000)**
ln trade openness	0.001	0.001	0.003	0.001	0.002	0.001
	(0.000)**	(0.000)***	(0.002)	(0.001)	(0.002)	(0.001)**
ln gdp/capita	-0.002	-0.002	0.005	-0.002	0.002	0.001
	(0.003)	(0.003)	(0.013)	(0.005)	(0.015)	(0.004)
difference in ln gdp/capita	-0.000	0.000	-0.002	0.000	-0.002	-0.000
	(0.000)	(0.000)	(0.002)	(0.001)	(0.002)	(0.001)
env commitments	-0.000	-0.000	0.000	-0.001	-0.000	-0.000
	(0.000)*	(0.000)**	(0.000)	(0.000)***	(0.001)	(0.000)***
EU	0.002	0.002	-0.009	0.012	0.018	0.001
	(0.009)	(0.009)	(0.044)	(0.017)	(0.050)	(0.036)
gov owned source	0.089	0.089	0.781	-0.418	0.778	0.042
	(0.022)***	(0.022)***	(0.099)***	(0.057)***	(0.114)***	(0.026)
partly indep source	0.365	0.366	1.242	-0.012	2.786	0.000
	(0.024)***	(0.024)***	(0.109)***	(0.042)	(0.126)***	(0.000)
affinity	0.051	0.048	0.115	-0.047	0.171	0.053
	(0.021)**	(0.021)**	(0.095)	(0.041)	(0.110)	(0.025)**
ln gdp	-0.002	-0.001	-0.007	-0.002	-0.004	-0.004
	(0.002)	(0.002)	(0.010)	(0.004)	(0.012)	(0.003)
difference in ln gdp	0.003	0.003	0.014	-0.001	0.010	0.004
	(0.001)***	(0.001)***	(0.005)**	(0.002)	(0.006)*	(0.002)**
basinsize	0.000	0.000	0.000	-0.000	0.000	0.000
	(0.000)***	(0.000)**	(0.000)***	(0.000)*	(0.000)***	(0.000)**
# riparians	0.006	0.006	0.018	-0.005	0.013	0.007
	(0.001)***	(0.001)***	(0.004)***	(0.002)**	(0.005)***	(0.001)***
pop dens	-0.000	-0.000	0.000	-0.000	0.000	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
scarcity	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000
	(0.000)***	(0.000)**	(0.000)***	(0.000)	(0.000)***	(0.000)*
mixed river	-0.013	-0.014	-0.025	0.012	-0.022	-0.003
	(0.004)***	(0.004)***	(0.020)	(0.008)	(0.023)	(0.005)
dyad spat lag	0.092	0.095	0.735	-0.096	1.620	0.115
	(0.019)***	(0.019)***	(0.087)***	(0.035)***	(0.100)***	(0.022)***
basin spat lag	0.598	0.598	2.748	0.300	3.300	0.605
	(0.016)***	(0.016)***	(0.073)***	(0.032)***	(0.084)***	(0.020)***
N	3885	3885	3885	3569	3885	2673

all regressions include country fixed effects
standard errors in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%

Table 4.10: *Robustness Checks H1, water quality subs., border-demarcating rivers*

	original	polity	MA	exp smooth	raw	w/out Nile,Danube
constant	-0.058	-0.026	-0.161	-0.046	-0.165	-0.313
	(0.060)	(0.064)	(0.199)	(0.110)	(0.244)	(0.113)***
lagged dep var	0.747	0.746	0.453	0.332	-0.296	0.014
	(0.020)***	(0.020)***	(0.066)***	(0.037)***	(0.080)***	(0.060)
winng coalit	-0.020		0.026	0.129	0.066	0.097
	(0.049)		(0.163)	(0.087)	(0.199)	(0.175)
winng coalit^2	0.017		0.005	-0.100	-0.053	-0.078
	(0.037)		(0.125)	(0.067)	(0.152)	(0.110)
democr		-0.005				
		(0.003)				
dem^2		0.000				
		(0.000)*				
# joint IGO	0.000	0.000	0.000	0.001	0.001	-0.000
	(0.000)**	(0.000)**	(0.000)	(0.000)***	(0.000)*	(0.000)
trade dep	-0.928	-1.243	-3.634	0.211	-5.482	-2.565
	(1.201)	(1.202)	(4.011)	(2.180)	(4.902)	(1.943)
ln trade openness	0.001	0.001	0.000	0.000	0.002	-0.003
	(0.001)*	(0.001)**	(0.002)	(0.001)	(0.003)	(0.002)*
ln gdp/capita	-0.002	-0.002	0.008	0.002	0.004	0.004
	(0.002)	(0.002)	(0.008)	(0.004)	(0.010)	(0.003)
difference in ln gdp/capita	0.000	0.000	0.002	-0.001	0.000	0.000
	(0.000)	(0.000)	(0.001)	(0.001)	(0.002)	(0.001)
env commitments	0.000	0.000	0.000	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
EU	-0.007	-0.007	0.005	-0.014	0.003	0.044
	(0.005)	(0.005)	(0.016)	(0.009)	(0.020)	(0.035)
gov owned source	0.164	0.163	2.000	0.154	2.113	-0.076
	(0.020)***	(0.020)***	(0.068)***	(0.077)**	(0.083)***	(0.021)***
partly indep source	0.349	0.349	1.099	0.102	2.549	0.000
	(0.015)***	(0.015)***	(0.049)***	(0.026)***	(0.060)***	(0.000)
affinity	-0.052	-0.060	-0.307	-0.207	-0.236	-0.001
	(0.034)	(0.034)*	(0.112)***	(0.062)***	(0.137)*	(0.031)
ln gdp	-0.003	-0.003	-0.029	-0.017	-0.026	-0.005
	(0.002)	(0.002)	(0.008)***	(0.004)***	(0.009)***	(0.003)
difference in ln gdp	0.000	-0.000	-0.000	-0.003	-0.000	-0.008
	(0.001)	(0.001)	(0.004)	(0.002)	(0.005)	(0.002)***
basinsize	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000
	(0.000)**	(0.000)*	(0.000)	(0.000)	(0.000)	(0.000)**
# riparians	0.004	0.004	-0.008	0.031	0.003	0.018
	(0.002)***	(0.002)***	(0.005)	(0.003)***	(0.006)	(0.006)***
pop dens	0.000	0.000	0.000	0.000	0.000	0.000
	(0.000)***	(0.000)***	(0.000)***	(0.000)	(0.000)***	(0.000)***
scarcity	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000
	(0.000)***	(0.000)***	(0.000)**	(0.000)	(0.000)*	(0.000)
mixed river	-0.043	-0.043	-0.080	-0.232	-0.097	-0.014
	(0.007)***	(0.007)***	(0.024)***	(0.013)***	(0.029)***	(0.013)
dyad spat lag	-0.258	-0.259	-0.867	-0.221	-0.930	-0.081
	(0.027)***	(0.027)***	(0.089)***	(0.053)***	(0.108)***	(0.021)***
basin spat lag	0.734	0.735	0.963	0.354	1.472	1.030
	(0.029)***	(0.029)***	(0.096)***	(0.066)***	(0.117)***	(0.026)***
N	1174	1174	1174	1133	1174	368

all regressions include country fixed effects
standard errors in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%

Table 4.11: *Robustness Checks H1 &, water quantity, border-demarcating rivers*

	original	polity	MA	exp smooth	raw	w/out Nile,Danube
constant	0.333	0.331	0.489	-0.172	1.035	0.256
	(0.035)***	(0.035)***	(0.132)***	(0.036)***	(0.147)***	(0.040)***
lagged dep var	0.746	0.747	0.724	0.310	-0.315	0.577
	(0.017)***	(0.017)***	(0.062)***	(0.015)***	(0.069)***	(0.029)***
winng coalit	0.030		0.133	-0.003	0.120	0.060
	(0.015)**		(0.056)**	(0.013)	(0.063)*	(0.019)***
winng coalit^2	-0.039		-0.182	0.004	-0.185	-0.075
	(0.016)**		(0.059)***	(0.014)	(0.066)***	(0.023)***
democr		0.001				
		(0.001)				
dem^2		-0.000				
		(0.000)				
# joint IGO	-0.000	-0.000	-0.000	0.000	-0.000	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)*	(0.000)	(0.000)
trade dep	-0.000	-0.000	0.000	0.000	-0.000	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
ln trade openness	0.001	0.001	0.002	0.001	0.002	0.001
	(0.000)***	(0.000)***	(0.001)**	(0.000)***	(0.001)*	(0.000)***
ln gdp/capita	-0.003	-0.004	-0.010	-0.001	-0.015	-0.001
	(0.002)*	(0.002)**	(0.006)	(0.002)	(0.007)**	(0.002)
difference in ln gdp/capita	-0.000	-0.000	-0.001	-0.000	-0.001	-0.000
	(0.000)	(0.000)	(0.001)	(0.000)	(0.001)	(0.000)
env commitments	0.000	0.000	0.001	0.000	0.002	0.000
	(0.000)***	(0.000)**	(0.000)***	(0.000)**	(0.000)***	(0.000)**
EU	-0.014	-0.015	-0.071	-0.000	-0.080	-0.035
	(0.006)**	(0.006)**	(0.022)***	(0.005)	(0.025)***	(0.021)*
gov owned source	0.082	0.081	0.451	0.272	0.446	0.158
	(0.013)***	(0.013)***	(0.048)***	(0.014)***	(0.054)***	(0.015)***
partly indep source	0.156	0.157	0.568	0.126	0.597	0.333
	(0.019)***	(0.019)***	(0.072)***	(0.021)***	(0.080)***	(0.023)***
affinity	0.043	0.045	0.321	0.011	0.379	0.034
	(0.013)***	(0.013)***	(0.047)***	(0.012)	(0.053)***	(0.014)**
ln gdp	0.000	0.000	0.003	0.001	0.002	-0.000
	(0.001)	(0.001)	(0.005)	(0.001)	(0.006)	(0.002)
difference in ln gdp	0.001	0.001	0.003	0.001	0.006	0.000
	(0.001)	(0.001)	(0.003)	(0.001)	(0.003)*	(0.001)
dem*waterdep	-0.000	-0.000	-0.006	0.000	-0.006	-0.002
	(0.000)***	(0.000)***	(0.001)***	(0.000)	(0.001)***	(0.000)***
water dependency	0.000	0.001	0.001	0.000	0.001	0.001
	(0.000)***	(0.000)***	(0.000)***	(0.000)***	(0.001)**	(0.000)***
basinsize	-0.000	-0.000	-0.000	0.000	-0.000	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)**	(0.000)	(0.000)
# riparians	0.000	0.000	0.001	-0.002	0.006	0.001
	(0.001)	(0.001)	(0.002)	(0.001)***	(0.002)***	(0.001)
pop dens	-0.000	-0.000	0.000	0.000	-0.000	-0.000
	(0.000)*	(0.000)	(0.000)	(0.000)***	(0.000)	(0.000)
scarcity	0.000	0.000	0.000	0.000	0.000	0.000
	(0.000)	(0.000)*	(0.000)	(0.000)	(0.000)	(0.000)*
mixed river	0.003	0.003	-0.013	-0.004	-0.014	-0.001
	(0.003)	(0.003)	(0.010)	(0.002)	(0.011)	(0.003)
dyad spat lag	0.115	0.113	0.292	-0.016	0.101	0.117
	(0.029)***	(0.029)***	(0.109)***	(0.026)	(0.121)	(0.030)***
basin spat lag	0.166	0.168	0.795	-0.007	0.868	0.084
	(0.023)***	(0.023)***	(0.086)***	(0.022)	(0.096)***	(0.025)***
N	3892	3892	3892	3573	3892	2679

all regressions include country fixed effects
standard errors in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%

Table 4.12: *Robustness Checks H1 & H2, joint management, border-demarcating rivers*

	original	polity	MA	exp smooth	raw	w/out Nile,Danube
constant	0.162	0.160	0.741	1.145	0.377	0.230
	(0.078)**	(0.078)**	(0.291)**	(0.216)***	(0.397)	(0.082)***
lagged dep var	0.516	0.516	0.935	1.014	0.206	0.414
	(0.011)***	(0.010)***	(0.039)***	(0.031)***	(0.054)***	(0.014)***
winng coalit	-0.020		-0.024	-0.060	0.006	0.042
	(0.035)		(0.131)	(0.088)	(0.179)	(0.041)
winng coalit^2	0.055		0.031	0.085	-0.019	-0.045
	(0.037)		(0.138)	(0.092)	(0.189)	(0.049)
democr		-0.001				
		(0.003)				
dem^2		0.000				
		(0.000)				
# joint IGO	0.000	0.000	0.002	0.002	0.001	-0.000
	(0.000)	(0.000)	(0.001)***	(0.000)***	(0.001)*	(0.000)
trade dep	0.000	0.000	0.000	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)***	(0.000)***	(0.000)***	(0.000)
ln trade openness	0.002	0.001	0.003	0.003	0.003	0.000
	(0.001)**	(0.001)**	(0.002)	(0.002)	(0.003)	(0.001)
ln gdp/capita	0.003	0.003	-0.002	-0.008	0.012	0.013
	(0.004)	(0.004)	(0.015)	(0.011)	(0.021)	(0.004)***
difference in ln gdp/capita	-0.000	-0.001	0.001	-0.000	-0.001	0.000
	(0.001)	(0.001)	(0.002)	(0.001)	(0.003)	(0.001)
env commitments	-0.000	-0.000	0.000	0.000	0.000	-0.000
	(0.000)	(0.000)	(0.001)	(0.000)	(0.001)	(0.000)
EU	0.007	0.008	-0.094	-0.091	-0.096	-0.006
	(0.014)	(0.014)	(0.052)*	(0.034)***	(0.071)	(0.043)
gov owned source	0.172	0.173	0.997	0.617	1.734	0.301
	(0.013)***	(0.013)***	(0.051)***	(0.035)***	(0.069)***	(0.021)***
partly indep source	0.079	0.078	-0.240	-0.110	-0.119	0.074
	(0.018)***	(0.018)***	(0.066)***	(0.072)	(0.091)	(0.018)***
affinity	-0.007	-0.007	-0.252	-0.215	-0.207	-0.029
	(0.030)	(0.030)	(0.114)**	(0.083)***	(0.155)	(0.030)
ln gdp	-0.002	-0.002	0.001	-0.007	0.008	-0.011
	(0.003)	(0.003)	(0.012)	(0.009)	(0.016)	(0.003)***
ln gdpd	-0.005	-0.004	-0.011	0.002	-0.011	-0.004
	(0.002)***	(0.002)**	(0.007)	(0.005)	(0.009)	(0.002)*
basinsize	-0.000	-0.000	-0.000	0.000	-0.000	-0.000
	(0.000)***	(0.000)***	(0.000)	(0.000)*	(0.000)	(0.000)**
# riparians	0.007	0.007	0.010	-0.014	0.012	0.004
	(0.001)***	(0.001)***	(0.005)**	(0.004)***	(0.006)*	(0.001)***
pop dens	-0.000	-0.000	0.000	0.000	0.000	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)***	(0.000)	(0.000)*
scarcity	-0.000	-0.000	-0.000	0.000	-0.000	-0.000
	(0.000)	(0.000)	(0.000)*	(0.000)**	(0.000)	(0.000)
mixed river	-0.027	-0.028	-0.035	-0.059	-0.082	-0.019
	(0.006)***	(0.006)***	(0.024)	(0.017)***	(0.032)**	(0.007)***
dyad spat lag	-0.080	-0.080	-0.214	-0.200	-0.386	-0.060
	(0.019)***	(0.019)***	(0.070)***	(0.049)***	(0.095)***	(0.019)***
basin spat lag	0.477	0.476	1.519	0.231	1.627	0.526
	(0.016)***	(0.016)***	(0.060)***	(0.049)***	(0.082)***	(0.019)***
N	3892	3892	3892	3573	3892	2679

all regressions include country fixed effects
standard errors in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%

Table 4.13: *Robustness Checks H1 & H2, border-crossing rivers*

	original	polity	MA	exp smooth	raw	w/out Nile,Danube
constant	-0.145	-0.128	-0.179	0.141	-0.586	-0.115
	(0.036)***	(0.036)***	(0.149)	(0.099)	(0.215)***	(0.034)***
lagged dep var	0.726	0.732	0.940	0.888	0.207	0.765
	(0.006)***	(0.006)***	(0.026)***	(0.017)***	(0.037)***	(0.007)***
winng coalit	-0.053		-0.141	-0.127	-0.276	0.005
	(0.022)**		(0.091)	(0.060)**	(0.131)**	(0.020)
winng coalit^2	0.028		0.075	0.077	0.235	-0.020
	(0.023)		(0.095)	(0.063)	(0.138)*	(0.022)
democr		-0.000				
		(0.002)				
dem^2		-0.000				
		(0.000)				
basinsize upstream	0.000		0.000	0.000	0.000	0.000
	(0.000)***		(0.000)**	(0.000)***	(0.000)	(0.000)***
demupsize	-0.000		-0.000	-0.000	-0.000	-0.000
	(0.000)***		(0.000)	(0.000)***	(0.000)	(0.000)***
# joint IGO	0.000	0.000	0.001	0.001	0.001	0.000
	(0.000)***	(0.000)***	(0.000)***	(0.000)***	(0.000)**	(0.000)**
trade dep	-0.000	-0.000	0.000	-0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
ln trade openness	0.001	0.001	0.003	0.004	0.005	0.001
	(0.000)***	(0.000)**	(0.002)**	(0.001)***	(0.002)**	(0.000)**
ln gdp/ cap	-0.000	0.001	0.010	-0.021	0.011	0.002
	(0.002)	(0.002)	(0.009)	(0.006)***	(0.014)	(0.002)
ln gdp/ cap diff	-0.000	-0.000	-0.000	-0.001	0.001	-0.001
	(0.000)	(0.000)	(0.001)	(0.001)	(0.002)	(0.000)**
env commitments	0.000	0.000	0.001	0.000	0.001	0.000
	(0.000)	(0.000)*	(0.000)**	(0.000)	(0.000)*	(0.000)***
EU	-0.049	-0.050	-0.262	-0.281	-0.296	-0.004
	(0.007)***	(0.007)***	(0.030)***	(0.020)***	(0.044)***	(0.008)
gov owned source	0.071	0.078	0.531	0.214	1.009	0.089
	(0.008)***	(0.008)***	(0.031)***	(0.021)***	(0.045)***	(0.009)***
partly indep source	0.069	0.073	0.633	0.216	1.175	0.050
	(0.008)***	(0.008)***	(0.033)***	(0.022)***	(0.048)***	(0.008)***
affinity	-0.001	-0.004	-0.073	0.049	-0.011	-0.012
	(0.012)	(0.012)	(0.051)	(0.034)	(0.074)	(0.011)
ln gdp	0.001	0.001	-0.012	-0.004	-0.015	-0.001
	(0.002)	(0.002)	(0.007)	(0.005)	(0.011)	(0.002)
difference in ln gdp	0.001	0.001	0.002	-0.001	0.003	0.000
	(0.001)	(0.001)	(0.004)	(0.003)	(0.005)	(0.001)
basinsize	0.000	0.000	0.000	-0.000	-0.000	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)***	(0.000)	(0.000)
# riparians	0.001	0.001	0.007	0.018	0.012	0.002
	(0.000)*	(0.000)	(0.002)***	(0.001)***	(0.003)***	(0.001)***
pop dens	-0.000	-0.000	-0.000	0.000	-0.000	-0.000
	(0.000)**	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)***
scarcity	0.000	-0.000	-0.000	0.000	-0.000	-0.000
	(0.000)	(0.000)	(0.000)**	(0.000)	(0.000)**	(0.000)
rivers w/ mixed direction	0.004	0.003	0.018	-0.002	0.020	0.005
	(0.004)	(0.004)	(0.016)	(0.010)	(0.023)	(0.003)
rivers w/ other direction	-0.002	-0.003	0.004	0.004	0.007	-0.003
	(0.003)	(0.003)	(0.013)	(0.009)	(0.019)	(0.003)
dyad spat lag	-0.040	-0.041	-0.071	-0.237	-0.090	-0.029
	(0.009)***	(0.009)***	(0.038)*	(0.025)***	(0.054)*	(0.008)***
basin spat lag	0.235	0.231	0.847	0.319	1.270	0.217
	(0.009)***	(0.009)***	(0.037)***	(0.024)***	(0.053)***	(0.009)***
N	7954	7955	7954	7896	7954	7018

all regressions include country fixed effects
standard errors in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%

Table 4.14: *Robustness Checks H3 (severity: withdrawal), water quantity*

	original	polity	MA	exp smooth	raw	w/out Nile,Danube
constant	-0.008	-0.007	-0.018	0.011	-0.079	-0.009
	(0.013)	(0.013)	(0.044)	(0.020)	(0.058)	(0.013)
lagged dep var	0.857	0.857	0.708	0.617	0.106	0.875
	(0.006)***	(0.006)***	(0.019)***	(0.008)***	(0.026)***	(0.006)***
winng coalit	0.006		0.012	0.004	-0.035	0.016
	(0.009)		(0.029)	(0.013)	(0.039)	(0.009)*
winng coalit^2	-0.024		-0.081	-0.015	-0.043	-0.036
	(0.009)***		(0.031)***	(0.014)	(0.041)	(0.010)***
democr		0.001				
		(0.001)				
dem^2		-0.000				
		(0.000)				
# joint IGO	0.000	0.000	0.000	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)*	(0.000)***	(0.000)	(0.000)
trade dep	0.000	0.000	-0.000	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)***	(0.000)	(0.000)
ln trade openness	0.000	0.000	0.001	0.001	0.001	0.000
	(0.000)**	(0.000)**	(0.001)*	(0.000)***	(0.001)**	(0.000)**
ln gdpc	-0.000	-0.000	-0.000	0.001	-0.005	0.001
	(0.001)	(0.001)	(0.003)	(0.001)	(0.004)	(0.001)
ln gdpcd	-0.000	-0.000	-0.001	-0.000	-0.001	-0.000
	(0.000)**	(0.000)	(0.000)	(0.000)*	(0.001)	(0.000)**
env commitments	0.000	0.000	0.001	-0.000	0.001	0.000
	(0.000)***	(0.000)***	(0.000)***	(0.000)	(0.000)***	(0.000)***
EU	-0.006	-0.007	-0.025	0.007	-0.043	0.002
	(0.003)**	(0.003)**	(0.010)**	(0.004)	(0.013)***	(0.003)
gov owned source	0.118	0.118	0.456	0.042	0.635	0.092
	(0.006)***	(0.006)***	(0.020)***	(0.009)***	(0.027)***	(0.006)***
partly indep source	0.140	0.141	0.580	0.051	1.197	0.143
	(0.007)***	(0.007)***	(0.026)***	(0.012)***	(0.034)***	(0.007)***
affinity	0.017	0.017	0.067	0.003	0.075	0.014
	(0.004)***	(0.004)***	(0.015)***	(0.007)	(0.019)***	(0.004)***
ln gdp	-0.001	-0.001	-0.003	0.001	0.001	-0.001
	(0.001)	(0.001)	(0.003)	(0.001)	(0.003)	(0.001)
ln gdpd	0.000	0.000	0.000	-0.001	0.001	0.000
	(0.000)	(0.000)	(0.001)	(0.001)**	(0.002)	(0.000)
basinsize	-0.000	-0.000	-0.000	0.000	-0.000	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
# riparians	0.000	0.000	0.000	-0.000	0.000	-0.000
	(0.000)	(0.000)	(0.001)	(0.000)	(0.001)	(0.000)
tot withdraw (km3/yr)	-0.000	-0.000	-0.001	-0.000	-0.001	-0.000
	(0.000)***	(0.000)***	(0.000)***	(0.000)***	(0.000)***	(0.000)***
scarcity	0.000	0.000	-0.000	0.000	-0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)**	(0.000)	(0.000)
water dependency	0.000	0.000	-0.000	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)***	(0.000)	(0.000)
sevautt	0.000	0.000	0.001	0.000	0.001	0.000
	(0.000)***	(0.000)***	(0.000)***	(0.000)***	(0.000)**	(0.000)***
rivers w/ mixed direction	0.003	0.003	0.002	-0.003	0.007	0.004
	(0.002)*	(0.002)*	(0.007)	(0.003)	(0.009)	(0.002)**
rivers w/ other direction	0.002	0.002	0.006	-0.002	0.009	0.001
	(0.002)	(0.002)	(0.006)	(0.002)	(0.007)	(0.002)
upstream downstream	-0.002	-0.002	-0.003	0.004	-0.003	-0.002
	(0.001)	(0.001)	(0.005)	(0.002)**	(0.006)	(0.001)
dyad spat lag	-0.017	-0.016	0.063	-0.131	-0.004	-0.011
	(0.010)*	(0.010)	(0.035)*	(0.016)***	(0.047)	(0.010)
basin spat lag	0.126	0.126	0.884	-0.050	0.910	0.085
	(0.013)***	(0.013)***	(0.046)***	(0.021)**	(0.061)***	(0.013)***
N	11847	11847	11847	11484	11847	9698

all regressions include country fixed effects
standard errors in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%

Table 4.15: *Robustness Checks H3 (severity: dep ratio), water quantity*

	original	polity	MA	exp smooth	raw	w/out Nile,Danube
constant	-0.008	-0.009	-0.017	0.010	-0.080	-0.010
	(0.013)	(0.013)	(0.044)	(0.020)	(0.058)	(0.013)
lagged dep var	0.855	0.855	0.702	0.615	0.101	0.872
	(0.006)***	(0.006)***	(0.019)***	(0.008)***	(0.026)***	(0.006)***
winng coalit	0.010		0.022	0.009	-0.026	0.021
	(0.009)		(0.030)	(0.013)	(0.040)	(0.009)**
winng coalit^2	-0.021		-0.069	-0.011	-0.034	-0.030
	(0.009)**		(0.031)**	(0.013)	(0.041)	(0.010)***
democr		0.001				
		(0.001)				
dem^2		-0.000				
		(0.000)				
# joint IGO	0.000	0.000	0.000	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)***	(0.000)	(0.000)
trade dep	0.000	0.000	-0.000	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)***	(0.000)	(0.000)
ln trade openness	0.000	0.000	0.001	0.001	0.001	0.000
	(0.000)**	(0.000)**	(0.001)	(0.000)***	(0.001)*	(0.000)*
ln gdp/capita	-0.001	-0.001	-0.002	0.000	-0.007	0.000
	(0.001)	(0.001)	(0.003)	(0.001)	(0.004)	(0.001)
difference in ln gdp/capita	-0.000	-0.000	-0.001	-0.000	-0.001	-0.000
	(0.000)*	(0.000)	(0.000)	(0.000)*	(0.001)	(0.000)**
env commitments	0.000	0.000	0.001	-0.000	0.001	0.000
	(0.000)***	(0.000)***	(0.000)***	(0.000)	(0.000)***	(0.000)***
EU	-0.007	-0.007	-0.028	0.006	-0.044	0.001
	(0.003)**	(0.003)**	(0.010)***	(0.004)	(0.014)***	(0.003)
gov owned source	0.117	0.117	0.453	0.041	0.633	0.092
	(0.006)***	(0.006)***	(0.020)***	(0.009)***	(0.027)***	(0.006)***
partly indep source	0.140	0.141	0.580	0.051	1.198	0.143
	(0.007)***	(0.007)***	(0.026)***	(0.012)***	(0.034)***	(0.007)***
affinity	0.014	0.014	0.052	-0.002	0.065	0.009
	(0.004)***	(0.004)***	(0.014)***	(0.006)	(0.019)***	(0.004)**
ln gdp	-0.000	-0.000	-0.001	0.002	0.002	-0.000
	(0.001)	(0.001)	(0.003)	(0.001)	(0.003)	(0.001)
difference in ln gdp	0.000	0.000	0.000	-0.001	0.001	0.000
	(0.000)	(0.000)	(0.001)	(0.001)**	(0.002)	(0.000)
basinsize	-0.000	-0.000	-0.000	0.000	-0.000	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
# riparians	0.000	0.000	0.000	-0.000	0.000	-0.000
	(0.000)	(0.000)	(0.001)	(0.000)	(0.001)	(0.000)
Tot Withdraw(km3/yr)	-0.000	-0.000	-0.000	-0.000	-0.001	-0.000
	(0.000)***	(0.000)**	(0.000)**	(0.000)***	(0.000)***	(0.000)**
scarcity	0.000	0.000	-0.000	0.000	-0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)*	(0.000)	(0.000)
water dependency	0.000	0.000	0.000	0.000	0.000	0.000
	(0.000)***	(0.000)***	(0.000)	(0.000)***	(0.000)	(0.000)**
sev*dem	-0.000	-0.000	-0.001	-0.000	-0.001	-0.000
	(0.000)**	(0.000)***	(0.000)*	(0.000)*	(0.000)	(0.000)***
rivers w/ mixed direction	0.003	0.003	0.002	-0.003	0.007	0.004
	(0.002)*	(0.002)*	(0.007)	(0.003)	(0.009)	(0.002)**
rivers w/ other direction	0.002	0.002	0.008	-0.002	0.009	0.001
	(0.002)	(0.002)	(0.006)	(0.002)	(0.007)	(0.002)
upstream downstream	-0.002	-0.002	-0.003	0.004	-0.003	-0.002
	(0.001)	(0.001)	(0.005)	(0.002)**	(0.006)	(0.001)*
dyad spat lag	-0.018	-0.017	0.059	-0.132	-0.007	-0.012
	(0.010)*	(0.010)*	(0.035)*	(0.016)***	(0.047)	(0.010)
basin spat lag	0.125	0.125	0.880	-0.051	0.908	0.084
	(0.013)***	(0.013)***	(0.046)***	(0.021)**	(0.061)***	(0.013)***
N	11847	11847	11847	11484	11847	9698

all regressions include country fixed effects
standard errors in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%

Table 4.16: *Robustness Checks H3 (severity), water quality*

	original	polity	MA	exp smooth	raw	w/out Nile,Danube
constant	-0.037	-0.040	-0.022	0.740	0.061	-0.068
	(0.024)	(0.024)*	(0.110)	(0.041)***	(0.130)	(0.027)**
lagged dep var	0.665	0.665	0.433	0.832	-0.671	0.640
	(0.009)***	(0.009)***	(0.039)***	(0.014)***	(0.046)***	(0.010)***
winng coalit	0.036		0.202	0.007	0.216	0.043
	(0.011)***		(0.052)***	(0.019)	(0.061)***	(0.013)***
winng coalit^2	-0.004		-0.104	0.000	-0.115	-0.024
	(0.012)		(0.053)*	(0.019)	(0.063)*	(0.014)*
democr		0.000				
		(0.001)				
dem^2		0.000				
		(0.000)				
# joint IGO	0.000	0.000	0.000	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)**	(0.000)	(0.000)
trade dep	0.000	0.000	0.000	-0.000	0.000	0.000
	(0.000)***	(0.000)***	(0.000)***	(0.000)***	(0.000)***	(0.000)***
ln trade openness	0.001	0.001	0.001	0.000	0.001	0.001
	(0.000)***	(0.000)***	(0.001)	(0.000)	(0.001)	(0.000)***
ln gdp/capita	-0.000	-0.001	0.006	-0.004	0.005	0.002
	(0.001)	(0.001)	(0.005)	(0.002)**	(0.006)	(0.001)
ln gdp/capita iff	0.000	0.000	-0.000	0.000	-0.000	-0.000
	(0.000)	(0.000)	(0.001)	(0.000)	(0.001)	(0.000)
env commitments	-0.000	0.000	0.000	-0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
EU	0.001	0.002	-0.016	-0.004	-0.010	0.004
	(0.004)	(0.004)	(0.018)	(0.006)	(0.021)	(0.006)
gov owned source	0.137	0.137	0.639	-0.137	0.932	0.116
	(0.012)***	(0.012)***	(0.054)***	(0.023)***	(0.064)***	(0.014)***
partly gov owned source	0.260	0.261	1.159	0.083	2.367	0.185
	(0.010)***	(0.010)***	(0.043)***	(0.015)***	(0.051)***	(0.022)***
affinity	0.013	0.014	-0.020	-0.067	0.014	0.014
	(0.007)*	(0.007)*	(0.032)	(0.012)***	(0.038)	(0.008)*
ln gdp	-0.002	-0.001	-0.011	0.001	-0.012	-0.003
	(0.001)*	(0.001)	(0.004)***	(0.002)	(0.005)**	(0.001)***
difference in ln gdp	0.000	0.001	0.005	-0.000	0.002	-0.000
	(0.000)	(0.000)	(0.002)**	(0.001)	(0.003)	(0.001)
basinsize	0.000	0.000	0.000	-0.000	0.000	-0.000
	(0.000)***	(0.000)***	(0.000)***	(0.000)***	(0.000)***	(0.000)**
# riparians	0.002	0.002	0.010	0.001	0.010	0.006
	(0.000)***	(0.000)***	(0.001)***	(0.000)***	(0.001)***	(0.000)***
pop dens	0.000	-0.000	0.000	0.000	0.000	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)***
democracy*severity	-0.000	-0.000	-0.000	-0.000	-0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)***
rivers w/ mixed direction	0.007	0.008	0.023	0.001	0.023	0.006
	(0.002)***	(0.002)***	(0.011)**	(0.004)	(0.013)*	(0.003)**
rivers w/ other direction	0.005	0.005	0.023	-0.003	0.027	0.006
	(0.002)***	(0.002)**	(0.009)**	(0.003)	(0.011)**	(0.002)***
upstream downstream	-0.007	-0.007	-0.018	-0.011	-0.016	-0.009
	(0.002)***	(0.002)***	(0.008)**	(0.003)***	(0.009)*	(0.002)***
dyad spat lag	0.067	0.067	0.583	-0.066	1.070	0.071
	(0.009)***	(0.009)***	(0.041)***	(0.015)***	(0.049)***	(0.009)***
basin spat lag	0.581	0.582	2.752	0.188	3.270	0.556
	(0.010)***	(0.010)***	(0.043)***	(0.017)***	(0.051)***	(0.010)***
N	11834	11834	11834	11474	11834	9688

all regressions include country fixed effects
standard errors in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%

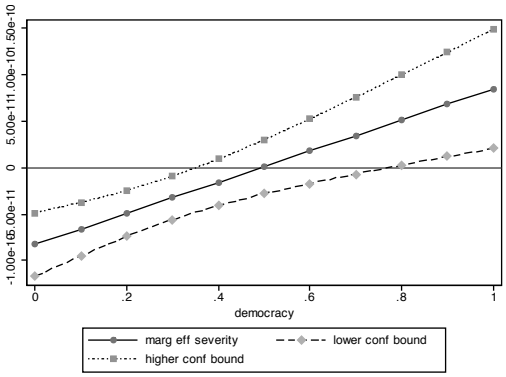

Figure 4.14: *Marginal effect severity (population density) for different levels of democracy, excluding Nile and Danube*

Table 4.17: *Robustness Checks H4 (salience), border-demarcating rivers*

	original	polity	MA	exp smooth	raw	w/out Nile,Danube
constant	-0.399	-0.413	-1.670	1.002	-3.035	-0.282
	(0.079)***	(0.080)***	(0.302)***	(0.229)***	(0.332)***	(0.094)***
lagged dep var	0.408	0.413	0.608	1.082	-0.300	0.337
	(0.011)***	(0.011)***	(0.041)***	(0.031)***	(0.045)***	(0.015)***
winng coalit	0.124		0.629	0.127	0.445	0.178
	(0.039)***		(0.149)***	(0.098)	(0.164)***	(0.051)***
winng coalit^2	-0.050		-0.492	-0.059	-0.367	-0.169
	(0.041)		(0.155)***	(0.102)	(0.170)**	(0.061)***
democr		-0.003				
		(0.003)				
dem^2		0.000				
		(0.000)				
low salience	0.307	0.342	1.353	0.385	2.151	0.289
	(0.012)***	(0.015)***	(0.046)***	(0.032)***	(0.051)***	(0.018)***
medium salience	0.375	0.358	1.254	0.656	1.724	0.300
	(0.027)***	(0.027)***	(0.102)***	(0.092)***	(0.112)***	(0.034)***
high salience	0.229	0.070	1.962	1.343	2.207	0.139
	(0.078)***	(0.070)	(0.297)***	(0.371)***	(0.327)***	(0.089)
saldem1	-0.088	-0.006	-0.315	-0.185	-0.311	-0.039
	(0.023)***	(0.001)***	(0.088)***	(0.062)***	(0.097)***	(0.037)
saldem2	-0.225	-0.008	-0.623	-0.759	-0.268	-0.154
	(0.046)***	(0.002)***	(0.174)***	(0.156)***	(0.191)	(0.061)**
saldem3	-0.233	0.005	-2.285	-1.177	-1.794	0.014
	(0.137)*	(0.006)	(0.520)***	(0.642)*	(0.571)***	(0.203)
# joint IGO	0.000	0.000	0.002	0.002	0.001	-0.000
	(0.000)	(0.000)	(0.001)**	(0.000)***	(0.001)	(0.000)
trade dep	0.000	0.000	0.000	-0.000	0.000	0.000
	(0.000)*	(0.000)**	(0.000)***	(0.000)***	(0.000)***	(0.000)
ln trade openness	0.001	0.001	0.006	0.004	0.001	0.000
	(0.001)	(0.001)	(0.003)**	(0.002)**	(0.003)	(0.001)
ln gdp/capita	-0.004	-0.003	-0.032	-0.025	-0.015	0.006
	(0.005)	(0.004)	(0.017)*	(0.012)**	(0.019)	(0.005)
difference in ln gdp/capita	-0.001	-0.001	-0.001	-0.000	-0.000	-0.000
	(0.001)	(0.001)	(0.002)	(0.002)	(0.003)	(0.001)
env commitments	0.000	0.000	0.002	-0.000	0.003	-0.000
	(0.000)	(0.000)	(0.001)***	(0.000)	(0.001)***	(0.000)
EU	-0.009	-0.009	-0.138	-0.089	-0.096	-0.081
	(0.015)	(0.015)	(0.058)**	(0.037)**	(0.064)	(0.054)
gov owned source	0.041	0.040	0.225	0.324	0.509	0.111
	(0.014)***	(0.014)***	(0.053)***	(0.038)***	(0.059)***	(0.022)***
partly indep source	0.034	0.044	-0.327	-0.156	-0.208	0.094
	(0.018)*	(0.018)**	(0.068)***	(0.060)***	(0.075)***	(0.025)***
affinity	0.057	0.062	0.075	-0.130	0.258	0.020
	(0.033)*	(0.033)*	(0.124)	(0.092)	(0.137)*	(0.037)
ln gdp	0.000	0.002	-0.005	-0.005	-0.009	-0.007
	(0.004)	(0.004)	(0.013)	(0.010)	(0.015)	(0.004)*
ln gdpd	0.002	0.002	0.005	-0.004	0.001	0.002
	(0.002)	(0.002)	(0.007)	(0.005)	(0.008)	(0.002)
basinsize	-0.000	-0.000	0.000	-0.000	-0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
# riparians	0.011	0.011	0.032	-0.016	0.037	0.006
	(0.001)***	(0.001)***	(0.005)***	(0.004)***	(0.006)***	(0.002)***
pop dens	-0.000	-0.000	-0.000	0.000	-0.000	-0.000
	(0.000)*	(0.000)	(0.000)*	(0.000)***	(0.000)	(0.000)
scarcity	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000
	(0.000)	(0.000)	(0.000)***	(0.000)	(0.000)***	(0.000)
mixed river	-0.015	-0.016	0.014	-0.020	0.027	-0.013
	(0.007)**	(0.007)**	(0.027)	(0.019)	(0.029)	(0.008)*
dyad spat lag	0.025	0.027	0.447	-0.100	0.364	0.018
	(0.016)	(0.016)	(0.062)***	(0.044)**	(0.069)***	(0.018)
basin spat lag	0.332	0.325	1.165	0.268	0.884	0.373
	(0.016)***	(0.016)***	(0.061)***	(0.045)***	(0.067)***	(0.021)***
N	3892	3892	3892	3573	3892	2679

all regressions include country fixed effects
standard errors in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%

Table 4.18: *Robustness Checks H4 (salience), border-crossing rivers*

	original	polity	MA	exp smooth	raw	w/out Nile,Danube
constant	0.152	0.150	0.617	0.111	1.624	0.137
	(0.032)***	(0.032)***	(0.122)***	(0.097)	(0.142)***	(0.030)***
lagged dep var	0.697	0.698	0.794	0.855	0.089	0.760
	(0.005)***	(0.005)***	(0.021)***	(0.016)***	(0.024)***	(0.006)***
democracy	0.033		0.008	0.096	0.073	0.000
	(0.019)*		(0.074)	(0.058)*	(0.086)	(0.018)
democracy^2	0.001		0.031	0.035	0.046	0.028
	(0.020)		(0.077)	(0.061)	(0.090)	(0.019)
democr		0.001				
		(0.001)				
dem^2		0.000				
		(0.000)				
recoded salience	0.225	0.227	0.982	0.255	1.712	0.214
	(0.006)***	(0.006)***	(0.021)***	(0.017)***	(0.025)***	(0.006)***
recoded salience*dem	0.067	0.003	0.260	0.069	0.081	0.053
	(0.010)***	(0.000)***	(0.038)***	(0.030)**	(0.044)*	(0.011)***
# joint IGO	0.000	0.000	0.001	0.001	0.001	0.000
	(0.000)*	(0.000)*	(0.000)***	(0.000)***	(0.000)*	(0.000)
trade dep	0.000	0.000	0.000	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
ln trade openness	0.001	0.000	0.000	0.003	0.000	0.001
	(0.000)**	(0.000)	(0.001)	(0.001)***	(0.001)	(0.000)**
ln gdp/capita	0.001	0.001	0.003	0.021	0.004	0.002
	(0.002)	(0.002)	(0.008)	(0.006)***	(0.009)	(0.002)
difference in ln gdp/capita	0.001	0.001	0.002	0.001	0.002	0.001
	(0.000)*	(0.000)**	(0.001)*	(0.001)	(0.001)*	(0.000)***
env commitments	0.000	0.000	0.000	0.000	0.000	0.000
	(0.000)	(0.000)*	(0.000)	(0.000)	(0.000)	(0.000)***
EU	0.021	0.022	0.135	0.245	0.042	0.012
	(0.006)***	(0.006)***	(0.025)***	(0.019)***	(0.029)	(0.007)*
gov owned source	0.040	0.040	0.118	0.120	0.206	0.034
	(0.007)***	(0.007)***	(0.026)***	(0.021)***	(0.030)***	(0.008)***
partly indep source	0.044	0.046	0.116	0.075	0.199	0.064
	(0.007)***	(0.007)***	(0.029)***	(0.023)***	(0.033)***	(0.008)***
affinity	0.008	0.009	0.057	0.057	0.035	0.012
	(0.011)	(0.011)	(0.041)	(0.033)*	(0.048)	(0.010)
ln gdp	0.002	0.001	0.005	0.004	0.000	0.001
	(0.002)	(0.002)	(0.006)	(0.005)	(0.007)	(0.001)
difference in ln gdp	0.001	0.001	0.003	0.001	0.008	0.001
	(0.001)	(0.001)	(0.003)	(0.002)	(0.004)**	(0.001)
basinsize	0.000	0.000	0.000	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)**	(0.000)***	(0.000)	(0.000)
# riparians	0.000	0.000	0.002	0.017	0.001	0.000
	(0.000)	(0.000)	(0.002)	(0.001)***	(0.002)	(0.001)
pop dens	0.000	0.000	0.000	0.000	0.000	0.000
	(0.000)***	(0.000)***	(0.000)	(0.000)	(0.000)	(0.000)***
scarcity	0.000	0.000	0.000	0.000	0.000	0.000
	(0.000)***	(0.000)***	(0.000)**	(0.000)	(0.000)	(0.000)***
basinsize upstream	0.000	0.000	0.000	0.000	0.000	0.000
	(0.000)***	(0.000)***	(0.000)	(0.000)***	(0.000)	(0.000)***
rivers w/ mixed direction	0.003	0.002	0.052	0.009	0.028	0.004
	(0.003)	(0.003)	(0.013)***	(0.010)	(0.015)*	(0.003)
rivers w/ other direction	0.000	0.000	0.011	0.015	0.007	0.003
	(0.003)	(0.003)	(0.011)	(0.008)*	(0.012)	(0.002)
dyad spat lag	0.018	0.018	0.008	0.232	0.043	0.013
	(0.008)**	(0.008)**	(0.030)	(0.024)***	(0.035)	(0.007)*
basin spat lag	0.138	0.139	0.420	0.185	0.519	0.119
	(0.008)***	(0.008)***	(0.030)***	(0.024)***	(0.035)***	(0.008)***
N	7954	7954	7954	7896	7954	7018

all regressions include country fixed effects
standard errors in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%

Chapter 5

Explaining the Spatial and Temporal Evolution of Water Quality Monitoring in Europe

Lucas Beck, Thomas Bernauer, Anna Kalbhenn

Abstract:

Effective monitoring is essential for effective environmental policy. We describe and explain the evolution of one of the most important international environmental monitoring networks in Europe, the one for water quality, in the time-period 1965-2005. Using data from the European Environment Agency and other sources we set up a GIS that contains information on the location of several thousand active monitoring stations in Europe. We then examine whether and to what extent the spatial and temporal clustering of reported monitoring activity is driven by domestic and international factors. Domestic factors, particularly income and democracy, turn out to have consistently positive effects on monitoring. International factors, notably peer group behavior, trade openness, and involvement in international organizations and global environmental regimes, have weaker effects than we expected. We also find that monitoring in international upstream-downstream settings is more extensive. From a policy-viewpoint, two results may be reasons for concern: EU membership has a consistently negative effect on monitoring; and while monitoring activity increases over time, it decreases in the run-up to the Water Framework Directive (in force since 2000).

5.1 Introduction

Comparisons of environmental performance across countries have become very popular, and international agencies and scientific institutions are compiling large amounts of data for such purposes. One prominent example is the Environmental Performance Index.[1] International environmental datasets are in fact widely used by policy-makers and their scientific advisors for 'diagnostic' and 'therapeutic' purposes; that is, for identifying problems, designing new policies, and implementing them.

Many users of such data tend to assume that environmental conditions, whenever measured, are measured with the best scientific methods and tools available and that existing data for any given location and environmental parameter at a specific point in time is of reasonably good quality and is reported accurately to international agencies. Yet, a cursory look at various sources of environmental information reveals that data coverage for most environmental indicators varies very strongly across countries and time. The main reason is that international datasets rely primarily on information that governments and their agents decide to collect and make available. The willingness and/or ability of governments to do so clearly differ across environmental issues, countries, and time.

Large differences in the quality of available data make it difficult to draw reliable conclusions from large-N cross-national comparisons of environmental conditions (e.g. in the environmental Kuznets curve research). However, they also raise an interesting research question; namely, what environmental, economic, political and other conditions can account for observable differences in environmental monitoring activity and thus ultimately also data quality. This question is interesting for two reasons. First, effective monitoring is, from a diagnostic and implementation viewpoint, obviously essential for effective environmental policy. Second, and related, the analysis of monitoring activity contributes to a better understanding of the factors that motivate improvements of countries' environmental behavior.

Prioritizing depth over breadth, we focus on what is widely regarded as one of the most important international environmental monitoring networks in Europe, the one for water quality. The analysis covers the time-period 1965-2005. Besides reasonably good data availability, focusing on this monitoring network reduces unit heterogeneity at least to some extent, making an analysis of other determinants easier. Income-related effects are very likely to overshadow other potential drivers of environmental monitoring activity if we compare, say, African countries with countries in Europe or North America. The same is likely to hold true if we focus on geographic areas and/or environmental issues where data collection and reporting efforts are subject to very weak or no international coordination or standardization. European countries are, in global comparison, rich, and the European Environment Agency (EEA) coordinates and sets standards for water quality monitoring and reporting.[2] Moreover, water quality monitoring

[1] http://epi.yale.edu/Home.

[2] In the EEA's own words: "Through Eionet {the EEA's reporting system}, the EEA brings together environmental data from individual countries concentrating on the delivery of timely, nationally validated, high-quality data. This forms the basis of integrated environmental assessments and knowledge that is disseminated and made accessible through the EEA website. This information serves to support environmental management processes, environmental policy-making and assessment, and public participation at national, European and global levels. Data which countries are obliged to report to the European level are collected

is an interesting candidate for study because it involves discrete choices, as expressed in the data that governments make available, that can be pinpointed in space and time.

Our analysis concentrates on outcome (dependent) variables that measure participation in the European water quality monitoring network as well as location-specific choices in this regard. We measure how many monitoring stations per geographic unit and year are reporting to the EEA network, and we seek to explain variation in this respect spatially and over time.

The following section describes changes in European water quality monitoring, i.e. the phenomenon to be explained. The subsequent section reviews the existing literature on domestic and international determinants of environmental policy behavior. We then discuss how the dataset was constructed and report the empirical results.

5.2 Spatial and Temporal Clustering of Reported Monitoring

Using information from the European Environment Agency's (EEA) reporting systems and from other sources we have constructed a dataset that contains information on the location and other characteristics of several thousand active monitoring stations in Europe. We have then examined whether and to what extent the spatial and temporal clustering of reported monitoring activity is driven by domestic and international factors.

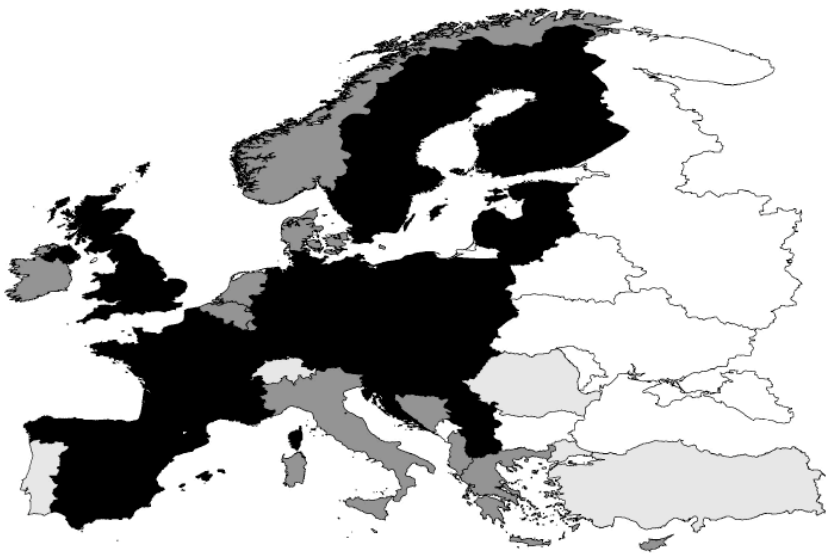

Figure 5.1: *Compliance with EEA requirements for water quality data reporting (2002-2005)*
(Based on data provided by the EEA. Low (light grey), medium (grey) and high compliance (black))

Figure 5.2 offers an intuitive illustration of differences in countries' monitoring behavior (and implicitly policy priorities) as measured by data reported to the European water quality moni-

and analysed in a transparent way by the EEA and ETCs to give a picture of the state of, and pressures on, Europe's environment... In this way, it also becomes possible to benchmark the environmental performance of countries." (EEA 2007b)

toring network ('Eionet priority data flows' program[3]), operated by the European Environment Agency (EEA). Dark shaded regions represent better compliance with the EEA's requirements (timeliness and completeness of the data provided), white areas refer to poor compliance. The figure reveals strong variation in reported monitoring efforts.

The analysis of information such as depicted in figure 5.2 can serve as a starting point and as a useful tool for the EEA in its efforts to convince countries to report more and better data on water quality. However, such ratings by the EEA are available only for very few years, and they contain no subnational spatial information (i.e., information on where countries monitor pollution). We have thus compiled a new dataset based on raw data from the EEA reporting systems and other sources.

Figure 5.2: *Evolution of the European water quality monitoring network*
(The slightly darker (light blue) shaded land areas are international river basins. Data for Portugal and Switzerland is not available. Based on information from `http://water.europa.eu/content/view/20/36/lang,en/.`*)*

Figure 5.2 depicts all locations from which water quality data has been reported to the EEA. It shows snapshots for four years in the time-period 1965 – 2005 (the statistical analysis uses annual data).[4] It indicates that monitoring activities, captured in terms of stations from which data is reported to the EEA in a given year, varies strongly both spatially and over time. The figure also identifies whether the reporting stations are located in a national or a transboundary (international) river basin (the latter are marked in slightly darker shade). Some patterns, such as the increasing density of reported monitoring activity in most countries over time and its expansion to Eastern Europe after the end of the Cold War, are obvious. More subtle patterns and their driving forces are identified by means of a statistical analysis.

Figure 5.2 shows the average number of all, domestic, and international monitoring stations

[3] EEA. 2006-2007. Eionet Priority Data Flows. Copenhagen.
[4] A film showing monitoring locations over time (yearly) is included in the support material.

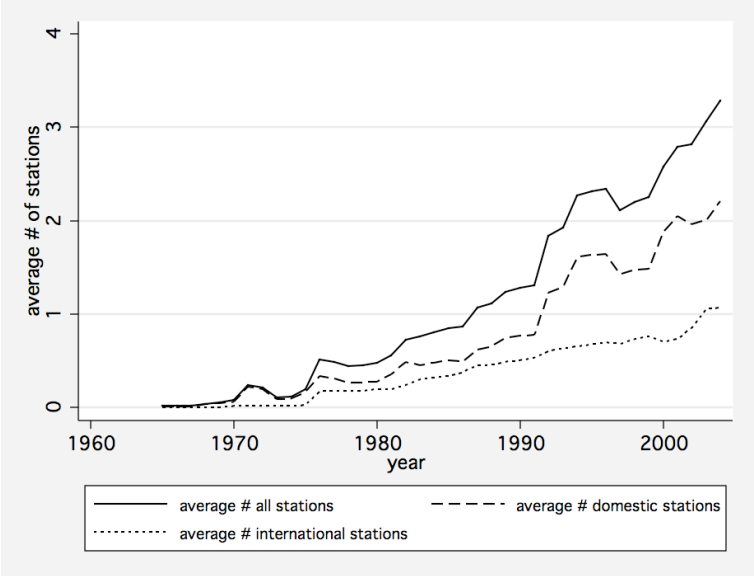

Figure 5.3: *Monitoring activity in domestic and international settings*

reporting to the EEA per river basin and year. International monitoring stations are defined as stations located in an international river system within a distance of 10 km from an international border. All other stations are defined as domestic monitoring stations (see section on data and method below). The figure shows that international monitoring has expanded particularly since the 1990s.

Using the EEA data to capture monitoring activity at specific locations and times means that we measure monitoring activity that is "revealed" by countries reporting water quality data to the EEA. This approach might create two types of challenges to the validity of our data for the dependent variable.

First, countries may operate monitoring stations whose data is not reported to the EEA. Unfortunately, no internationally commensurable data is available on such non-reported monitoring. This missing information could affect our results if the extent of non-reporting was significantly correlated with the explanatory variables in our model. We could not identify strong prima facie reasons for such correlations. However, future research could carry out surveys of national authorities to identify whether there are any systematic patterns in respect to which stations countries select for reporting to the EEA. Interviews we conducted with EEA officials indeed suggest that the EEA imposes only rather broadly defined guidelines on countries and the selection of stations is thus largely in the hands of national authorities. We return to the issue in the concluding section.

Second, our dataset extends further back in time than the initiation of the EEA monitoring network (the EEA and Eionet became operational in 1994). This implies that countries, once they started reporting data to the EEA, also reported backwards in time. In addition, reported data has been revised over time in some cases. This pattern is very common in most international data collection efforts, for example by those of the World Bank and the OECD. It means, of

course, that we do not, strictly speaking, measure reported monitoring activity in a given year. Rather, our data reflects the monitoring activity revealed through choices of governmental agencies in the time period 1994 – 2005. However, we believe that backward reported data reflects monitoring priorities in the year of measurement, which is why we use covariates that correspond to the date of monitoring (even though reporting might have taken place at a later point in time). Again, we have no strong prima facie reason to assume that these choices are systematically correlated with our explanatory variable. Hence we think that our approach is, de facto, the only feasible approach and is unlikely to produce biased statistical estimates.

5.3 Domestic and International Driving Forces

Quantitative (statistical) comparisons of environmental policy across countries focus mainly on explaining variation in either national policy-output (political, legal, administrative commitments) or policy-outcomes/impacts (pollution, environmental quality) (e.g. Grossman & Krueger 1995, Jahn 1998, Neumayer 2002*a*,*b*, Neumayer & De Soya 2005, Ward 2006, Li & Reuveny 2006). Some work describes and explains cross-national variation in international environmental commitments (e.g. Fredriksson & Gaston 2000, Neumayer 2002*a*,*b*, Beron et al. 2003, Fredriksson & Ujhelyi 2006, Roberts et al. 2004, Zilbauer 2005, von Stein 2008, Bernauer et al. 2009). And a few studies account for transboundary environmental policy-outcomes/impacts (Sigman 2002, 2003, 2004, Bernauer & Kuhn 2009).

Our work is motivated by three types of problems or gaps in this literature. First, existing studies of environmental policy may suffer from selection bias because, as noted above, the available environmental data that is used to measure policy outcomes / impacts is often highly incomplete and relies heavily on monitoring and reporting by governments and their agents. For example, studies by Sigman (2002, 2003, 2004) and Bernauer & Kuhn (2009) rely on data whose coverage of river basins, countries and years is highly uneven, particularly in the case of GEMS[5] data on water quality. Some countries have set up more monitoring stations, or they report data from more monitoring stations than others, or both. Some countries report more stations that measure transboundary pollution flows whereas other countries' reporting efforts appear to focus more on domestic watercourses. Stations are reported from at different points in time, the pollution parameters reported differ substantially, and so does the number of measurements per unit of time. These circumstances may affect empirical findings because monitoring stations are not randomly distributed over domestic and transboundary water systems and countries remain free with respect to where they locate monitoring stations on their territory. Governments also have a rather large degree of freedom with respect to what they measure, and when and what they report to international monitoring networks, such as those of GEMS and the EEA. Consequently, downstream countries may, for example, prefer to place monitoring stations immediately after the respective river enters their country to demonstrate that they are victims (i.e. involuntarily importing pollution from their upstream neighbour), but might be more reluctant to place monitoring stations at locations where self-inflicted pollution could become apparent. Studies using

[5] The United Nations Global Environment Monitoring System (GEMS) Water Programme: `http://www.gemstat.org/`

other large environmental datasets, such as those offered by CIESIN[6] and UNEP[7], face (and usually ignore) essentially the same problem. Using EEA data for European rivers[8], Bernauer & Kuhn (2009) observe that pollution measured at stations upstream of national borders is not systematically lower than pollution measured downstream of national borders. This suggests that strategic over- or underreporting of pollution may not be a big problem – we might expect upstream countries to select stations that report lower pollution levels, and downstream countries to do the opposite. Nonetheless, more systematic analysis is required in order to understand how countries collect and report environmental data into international monitoring networks.

Second, the obvious spatial and temporal clustering of monitoring activity described in the previous section is an interesting and policy-relevant phenomenon worth studying in its own right. Monitoring is important for designing and implementing effective environmental policies and can thus serve as an indicator for environmental policy priorities. We could not identify any quantitative study that systematically compares and explains the environmental monitoring behavior of countries.

Third, explanations of cross-national variation in environmental policy focus heavily on country-internal characteristics and, with very few exceptions (e.g. Ward 2006, Jahn 2006*a*, Bernauer et al. 2009), ignore international determinants.[9] That is, they pay only scant attention to the fact that countries' policy choices and practices may be interdependent: i.e., that choices or practices of one country with respect to a particular environmental problem may affect the behavior of other countries in the same area. Similarly, existing studies do not sufficiently account for the fact that, beyond specific interdependency effects (we will call this phenomenon contingent behavior), countries' behavior is also likely to be influenced by the extent to and forms in which they are, at a more general level, involved in networks of international policy-making.

We seek to explain the spatial and temporal clustering of environmental monitoring choices – as reflected in water quality reporting to the EEA – with two types of variables. The first pertains to country characteristics, the second to international determinants. Zilbauer (2005), for instance, argues that domestic factors, such as democracy and interest groups, are more important than international factors in explaining international environmental commitment. In contrast, Jahn (2006*a*) claims that international factors – defined in his analysis as spatial lags conceptualized in terms of geographic distance, trade relations, cultural proximity, and EU membership are equally important determinants of national environmental performance. Zilbauer examines ratification behavior with respect to five global environmental treaties (climate change, biodiversity, hazardous substances, desertification, ozone layer) and finds strong empirical support for his argument. Similarly, Jahn is able to demonstrate that his spatial lag variables have a significant effect on the environmental performance of 18 OECD countries. The two studies just mentioned focus on different dependent variables. Moreover, effects of domestic variables

6 The Center for International Earth Science Information Network (CIESIN): http://www.ciesin.org/

7 The United Nations Global Environment Outlook Data Portal: http://geodata.grid.unep.ch/

8 European Environment Agency, The Water Information System for Europe (WISE), http://water.europa.eu/content/view/20/36/lang,en/

9 Jahn (1998) uses spatial lag models to explain the environmental performance of 18 OECD countries in 1960-2002. Ward (2006) studies the effect of network centrality – the extent to which countries are involved in networks of international regimes – on national level environmental policy-outcomes. Bernauer et al. (2009) explain ratification behavior vis-à-vis global environmental agreements in terms of domestic and international determinants.

do of course not preclude effects of international factors. It is quite intuitive to expect that both types of variables will have an effect. However, only empirical analysis can help in resolving this issue.

We derive eight hypotheses from the literature just discussed and test them empirically. Hypotheses 1-3 concentrate on domestic factors, whereas hypotheses 4-8 emphasize a country's relationship with other countries. We present the theoretical arguments underlying each hypothesis in very brief form in order to leave more room for the empirical analysis.

Our first hypothesis relates to environmental pressure, whose effect is theoretically ambiguous. On the one hand, it may motivate countries to monitor more and participate more actively in international monitoring networks. The reason is that countries experiencing stronger environmental pressure are, for a variety of reasons (e.g. public pressure), likely to be more interested in solving the problem (Sprinz & Vaahoranta 1994). On the other hand, it may also encourage governments to avoid 'bad news' and/or international shame. To that end, policy-makers in countries experiencing stronger environmental pressure may seek to avoid monitoring and/or reporting. Even though the outcome is theoretically ambiguous, we formulate hypothesis H_1 in terms of the first possibility.

> **H1:** Countries tend to report more from river basins exposed to greater environmental pressure.

The environmental Kuznets curve literature (e.g. Torras & Boyce 1998) postulates that public demand for environmental protection tends to increase with income. And so does the financial and technological capacity of countries to address environmental problems. Depending on the particular environmental problem, this income-environment relationship may exhibit different functional forms (e.g., inverted U-shape, N or S-shape, linear). As a corollary, we expect that richer countries have better financial, technical and administrative capacities as well as stronger incentives (due to stronger public demand) to monitor water quality and report data to the EEA.

> **H2:** Richer countries tend to report more.

Several authors have shown that democratic countries are, ceteris paribus, more likely to engage in international environmental commitments than non-democracies, and that their domestic environmental performance tends to be better (e.g. Bernauer & Koubi 2009). We expect this effect to appear also with regard to the reporting of environmental data, since monitoring is an essential component of effective domestic and international environmental policy.

> **H3:** More democratic countries tend to report more.

The existing literature proposes contradictory arguments on the effects of trade openness on environmental protection (e.g. Neumayer 2002*a*). Whereas some authors claim that trade undermines environmental policy and produces more environmental degradation, other authors

argue that "trading-up" effects materialize in many environmental areas (Bernauer & Caduff 2004). The empirical evidence is ambiguous. Some studies demonstrate positive effects of trade openness on domestic environmental quality and international environmental commitments (Neumayer 2002*a*). Other studies find no significant or even negative effects (Bernauer et al. 2009). Extension of existing theoretical arguments on the trade-environment relationship to environmental monitoring and reporting is straightforward since the latter reflects the willingness and capacity of governments to deal with water pollution. With a view to the contradictory theoretical arguments and empirical evidence in the existing literature we do not have any strong presupposition. However, we start by formulating hypothesis H_4 in terms of the first possibility (positive trade effect).

H4: Countries that are more open to international trade tend to report more.

Following some previous theoretical and empirical work (e.g. Ward 2006, Bernauer et al. 2009, Ruoff 2009*a*) we expect that the embeddedness of countries in international institutions is likely to have positive spill-over effects on environmental monitoring and reporting activity. The reason is that stronger international involvement, in general terms (i.e. not specific to environmental monitoring), facilitates transfers of know-how, technology and financial support (notably in the case of poorer countries) that may also benefit water quality monitoring efforts. It also exposes environmental laggard countries to greater reputational costs and pressure from "greener" countries. We will capture the involvement in international institutions with indicators measuring membership in international organizations and ratification of global environmental agreements.

H5a: Countries that are more involved in international organizations tend to report more.

H5b: Countries that are more involved in global environmental agreements tend to report more.

Membership in the EU is obviously important because it subjects the countries concerned to the acquis communautaire in the environmental policy realm. Environmental monitoring activities have become an increasingly important area of activity in this regard. Moreover, EU membership increases funding opportunities and access to new technologies and scientific know-how through EU-sponsored activities. This is likely to support monitoring activity particularly in lower-income EU member states. Consequently, we expect EU membership to have a positive effect on monitoring, including monitoring of transboundary water quality. We expect the latter effect because EU membership 'entangles' countries into a tighter economic and political relationship that may serve as a source of leverage for countries at the receiving end of transboundary pollution flows (Bernauer & Kuhn 2009).

H6: EU member countries tend to report more.

Finally, hypothesis 7 stipulates that the monitoring behavior of a given country is influenced by the monitoring behavior of other countries. Specifically, we assume that countries pay most attention to what other countries in the same income bracket do (see also Braun et al. 2007). The underlying argument is that a given government is more likely to deem a particular extent of monitoring affordable, feasible, or politically appropriate if other countries with similar financial means have this level of monitoring activity in place.

> **H7:** Countries report more if other countries at the same income level have done so previously.

5.4 Empirical Design, Data, Statistical Approach

Our dependent variable measures the monitoring activity of countries as it appears in reporting to the EEA monitoring network. As noted above, this approach is mandated by constraints on data availability. We implement the analysis for three samples, each of which relies on a specific definition of the dependent variable (Table 1).

In the first sample, the dependent variable measures the number of active (reporting) monitoring stations per country, river basin and year. This sample includes observations for up to 41 countries[10], 328 river basins, and 40 years (1965-2005).

The second sample covers "domestic" monitoring stations. Our definition of domestic extends to all stations except those located in an international river system within a distance of 10 km from an international border. This sample includes observations for up to 41 countries, 328 river basins, and 40 years (1965-2004).

The third sample covers „international" monitoring stations. Those are stations located in an international river system within a distance of 10 km from an international border (Ganser 2007). An international river system is a catchment area that extends beyond national borders and involves two or more countries. This sample includes observations for up to 41 countries, 299 river basins, and 40 years (1965-2004).

With these three samples (all stations, domestic stations, international stations) we are able to examine whether there is a location-effect in the data. We also examine the effect of international river geography. In particular, we are interested in whether there are differences between upstream-downstream and other settings.

Note that, for the sample and time period analysed, the number of countries varies over time (e.g., due to the unification of Germany or the disintegration of former Yugoslavia). Changes in the number of countries also have effects on the distinction of domestic and international river basins.

Defining the dependent variable in terms of the number of (reported) monitoring stations per

[10] This number varies over time since the number of independent states in Europe has changed during our period of investigation.

Table 5.1: *Samples, units of analysis, dependent variables, population*

	Unit of analysis	**Dependent variable**	**Population**
Sample 1: All monitoring stations	Country per river basin and per year	Number of active (reporting) monitoring stations per country and river basin and year	Up to 45 countries[A], 327 river basins, and 40 years (1965-2004)
Sample 2: Domestic monitoring stations	Country per river basin and per year	Number of active (reporting) monitoring stations located in non-international river basins or in international river basins more than 10 km from the relevant international border	Up to 45 countries[A], 327 river basins, and 40 years (1965-2004)
Sample 3: International monitoring stations	Country per international river basin and per year	Number of active (reporting) monitoring stations located in an international river basin within a distance of 10 km from the relevant international border	Up to 45 countries[A], 299 river basins, and 40 years (1965-2004)

[A] This number varies since the number of independent states in Europe has changed during our period of investigation (e.g. due to the collapse of the Soviet Union).

country-river basin-year raises the question of proportionality and context. For example, some countries' water systems are largely confined to the respective national territory; other countries are located in international river basins. And countries differ very much in geographical size. Rather than controlling for such effects by defining monitoring and reporting activity proportional to country size, we include country fixed effects to control for time-invariant unit heterogeneity.

Focusing on the number of monitoring stations reporting to the European network can offer first insights into the extent of monitoring. But it does not tell us how many and what types of pollutants these stations measure, and how often (within any given year). This limitation is dueci to the fact that construction of a dataset for the number of reporting stations is in itself a very complex and time-consuming task (see below). Further research will have to show whether our empirical findings are also supported by data that measures monitoring activity in greater detail.

We rely on EEA data for the location of active monitoring stations as well as data from other sources (see below) to set up a geographic information system (GIS). First we define and distinguish between national and international watersheds and rivers by connecting hydrological maps to political boundaries. International watersheds and rivers are defined as aquatic systems that have a common terminus, in most cases an outlet to the ocean, and are shared by two or more countries. National watersheds and rivers also have a common terminus (outlet to the ocean), but are located entirely within a single country.[11] Second, we identify the position of the

[11] We decided not to use existing GIS layers for international river systems in Europe (e.g. Wolf et al. 2005),

monitoring stations with reference to rivers, watersheds and political boundaries. This includes the riparian position, distance to international boundaries, and also the positioning in the same basin relative to other stations. In particular, we distinguish national and international monitoring stations and upstream-downstream settings from other geographic settings. International stations are defined as stations located in an international basin within a distance of up to ten kilometres from an international border. Figure 5.4 illustrates this data construction process.

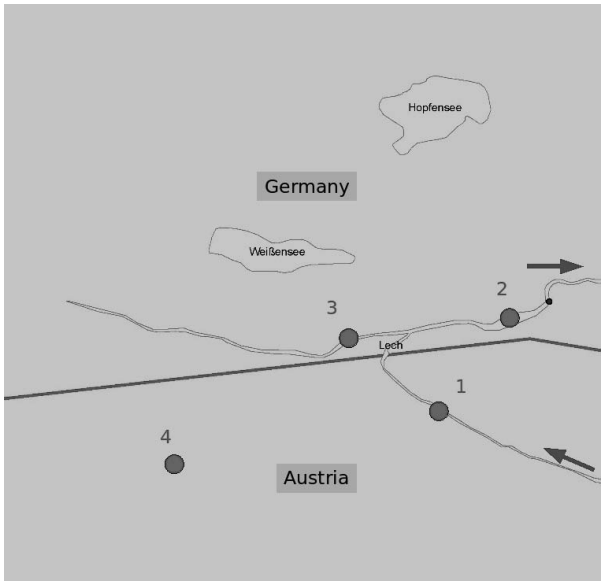

Figure 5.4: *Example of location of monitoring stations near borders*
((1) upstream, (2) downstream, (3) national station (this part of the river does not cross the international border), (4) not identifiable.)

Our GIS is based on the following spatial data sources:

1. Information on location and station properties is taken from the EEA databases operating in the context of the Eionet-Waterprocess (EEA 2007a). This data does not describe the position of a station in terms of up- or downstream location or in relation to political boundaries. Moreover, some station location data from the original dataset (Version 7) had to be adjusted manually because some reported locations did not correspond with reality or other datasets we used to cross-check the EEA data. As illustrated in Fig. 4, we also found some stations that could not be attributed to any water system – we assigned these stations to a specific river basin if plausible/possible and removed the other non-attributable stations from our GIS.

2. Information from the EEA European river catchments database (Bredahl and Sousa 2006). This database covers national and international watersheds. To the extent possible this information was merged with information from the Shared River Basins Database by Owen et al. (2004). Basins with an area of less than one square kilometre were excluded.

but used new data because existing layers are not available at a level of detail and precision that would allow us to connect the EEA data on monitoring station location to particular domestic and international rivers.

3. Information from the CCM River and Catchment Database (Vogt et al 2003 and 2007a) was used to identify the location of monitoring stations within catchments as well as partial river length and catchments. This database offers a hierarchical set of river segments and catchments, structured by hydrological feature codes based on the Pfafstetter system, which forms a basis for queries on topological relationships within the database (Vogt et al 2007b). The CCM2 database offers additional possibilities for characterizing the relative position of monitoring stations.

4. For GIS layers showing country borders and major rivers we used standard datasets provided by the Environmental Systems Research Institute (ESRI) and data from the GIS of the European Commission (GISCO NUTS). We adjusted this data for changes over time in the delineation of country boundaries (e.g., the unification of the two Germanies).

5. For information on precipitation we use average values derived from CRU time series between 1901 and 2002 at a 0.5 degree resolution (Mitchel et al. 2003). Together with the catchment area derived from the CCM2 dataset, this information is used as an indicator for discharge at each point.

Characterizing and positioning the monitoring stations in the European rivers and catchments is more difficult than it might seem. All stations that we define as international stations fall into a buffer of 10 km around international borders. This reference distance seems reasonable because we are dealing with a large geographic area. In addition to difficulties emanating from our use of data that differs in accuracy and stem from different sources there is an unavoidable deformation bias due to the projection of different layers in the GIS system. This reduces the overall accuracy of our data when measuring distances. In the CCM River database, for example, the reported total accuracy is 2662m for the location of river confluences at a confidence interval of 95% (Vogt et al. 2003).

Similar difficulties exist in characterizing rivers and monitoring stations in international basins near the ocean, where basins are usually small and the intersection with political boundaries is not always clear. Improved characterizations in our dataset lead to some differences between our dataset and the International River Basin Register of the Transboundary Freshwater Dispute Database (Wolf et al. 2005), notably with respect to Scandinavia and Eastern Europe. Fig. 1 and 2 in the appendix show two maps to illustrate these differences. Fig. 3 in the appendix illustrates additional challenges in creating the GIS.

We then extract the data for our dependent variables from the GIS and merge it with data for the explanatory variables. Data for the explanatory variables was taken from various sources, as shown in Table 2.

The dependent variable is the number of monitoring stations in a given country and water system (river basin) per year reporting to the EEA network. It thus appears most appropriate to model the data generating (reporting) process with event count models (cf. Long 1997, 230ff). Because of overdispersion, we opted for negative binomial rather than poisson regressions. Note that we might face positive contagious overdispersion since the reporting of monitoring stations might not be independent, i.e. if one monitoring station reports it might be more likely that other stations also report. Since we are dealing with time-series-cross-sectional data we use country

Table 5.2: *Explanatory variables and data sources*

Variable	Description	Source
Environmental pressure	Population density. We use population data from the Landscan Global Population Dataset (Landscan, 2005). Time series from 1965 to 2005 are estimated backward using UN (UNSTAT, 2008) and Eurostat national population estimates (Eurostat, 2008) that are based on national census statistics. The resulting dataset includes spatially disaggregated population estimates since 1965 with a spatial resolution of 30" x 30".	Landscan (2005), UNSTAT (2008), Eurostat (2008)
Income, income group	GDP/capita; income groups are defined as low, middle, high (according to the empirical sample distribution)	Heston et al. (2006)
Democracy	Revised combined Polity IV score	Marshall & Jaggers (2004), Gleditsch (2008)
Trade openness	Sum of exports and imports divided by GDP	Gleditsch (2002); Heston et al. (2006)
Trade intensity	Ratio of the sum of exports and imports of country i to/from country j to the sum of exports and imports of country i	Gleditsch (2002); Heston et al. (2006)
Membership in intergovernmental organizations (IGO)	Number of (joint) memberships in IGOs	Pevehouse et al. (2004)
Global environmental policy involvement	Cumulative number of ratifications of global environmental treaties	Own data generated from data provided by Ronald Mitchell and CIESIN/ENTRI
EU membership		`http://europa.eu/abc/european_countries/index_en.htm`
River type	Upstream/downstream, other geographic setting (dummy variable)	Own data
Agricultural landuse	Land principally occupied by agriculture, with significant areas of natural vegetation	Corine land cover 2000, EEA (2007c)
Basinarea m2 in country		Vogt, J. et al. (2007b)

fixed effects to account for possible unit heterogeneity. As a robustness check, we have also estimated all models with the quasi maximum likelihood approach suggested by Wooldridge (1997); the results are shown in the appendix. Descriptive statistics for all variables and a list with countries included in the samples can be found in the appendix.

5.5 Results

Table 3 summarizes the main results of our analysis.

Table 5.3: *Main Results*

	Model 1: All stations	**Model 2** Domestic stations	**Model 3** International stations
Environmental pressure	0.172	0.150	0.085
	(0.013)***	(0.016)***	(0.028)***
Income	1.488	1.592	1.682
	(0.127)***	(0.153)***	(0.307)***
Democracy	0.158	0.189	0.095
	(0.011)***	(0.014)***	(0.021)***
Trade openness	-0.000	-0.000	0.000
	(0.000)***	(0.000)	(0.000)
IGO membership	-0.006	-0.015	-0.006
	(0.004)	(0.005)***	(0.010)
MEA membership	0.002	0.004	-0.001
	(0.002)	(0.002)*	(0.005)
EU membership	-0.811	-0.678	-0.539
	(0.077)***	(0.091)***	(0.193)***
Income group	0.016	0.024	0.024
	(0.003)***	(0.004)***	(0.008)***
River type	0.875	0.089	2.660
	(0.068)***	(0.106)	(0.126)***
Agricultural landuse	-0.000	-0.000	
	(0.000)***	(0.000)***	
Basinarea	0.000	0.000	0.000
	(0.000)***	(0.000)***	(0.000)***
Year	0.078	0.068	0.073
	(0.006)***	(0.007)***	(0.016)***
1998	-0.247	-0.145	-0.506
	(0.092)***	(0.110)	(0.226)**
1999	-0.328	-0.266	-0.390
	(0.093)***	(0.114)**	(0.212)*
2000	-0.342	-0.254	-0.208
	(0.089)***	(0.106)**	(0.203)
Constant	-171.077	-153.795	-163.111
	(12.279)***	(14.235)***	(31.077)***
Observations	10332	10260	5523
Number of groups	28	27	25
Log-Likelihood	-8395.415	-6288.238	-1209.752

negative binomial regressions, country fixed effects, standard errors in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%.

Model 1 in Table 3 shows the results for all reporting monitoring stations in a country and basin, Model 2 for the subsample of domestic stations, and Model 3 for the subsample of international stations (those located in an international river basin within 10 km of the international border).

The results shown in Table 3 indicate that population density has a positive effect on reported monitoring in all three samples. This result supports the hypothesis that countries are more likely to monitor and report data from stations located in basins that experience more environmental pressure (assuming that more densely populated basins experience more environmental pressure). Democracy, and income have the expected positive effect on reported monitoring. The effect of trade openness is statistically significant and negative for the sample including all stations, but insignificant for the other two samples. Regarding membership in global environmental agreements, we only observe a statistically significant positive effect for the domestic sample. The coefficient is statistically insignificant for the other two samples. The effects of involvement in international organizations and EU membership cut against our hypotheses. The coefficient on IGO membership is, however, only statistically significant for the domestic sample. The effect of EU membership is significant and negative in all three models. One interpretation for the unexpected EU-effect is that, at the beginning of our period of analysis, most of the countries in our dataset were not yet members of the EU, but many were aspiring to become EU members. Countries seeking to join the EU may thus have engaged in greater efforts to „establish credit“ with the EU by increasing their reporting. The EEA has no legal enforcement mechanism that could be used to enhance data reporting and such reporting takes place on a (from an EU legal viewpoint) voluntary basis. Whereas reporting efforts might thus reflect countries' attempts to become ‚good European citizens', enforcement has to rely on naming and shaming of laggard countries.[12]

As argued in hypothesis 7, if countries in a given income group participate more actively in the monitoring network others in that group tend to follow this trend.

We observe more reported monitoring in international upstream-downstream settings than in other international settings. Such settings are defined in our analysis in terms of rivers that cross from one country into another, rather than flowing along an international border or corresponding to some other geographic pattern (e.g. lakes). The positive effect of upstream-downstream settings is likely to reflect the fact that such settings are usually more prone to international conflict because they lend themselves to beggar-thy-neighbour behaviour (e.g. Bernauer & Kuhn 2009). Hence they attract greater attention from policy-makers and their agents, who decide on the location of monitoring activity.

Figure 5.5 suggests, however, that there is only a weak beggar-thy-neighbour effect in the country-specific location of monitoring stations. We had suspected that we would – in international upstream-downstream settings – find more monitoring downstream of the international border, the assumption being that downstream countries have an incentive to demonstrate their victim status, whereas upstream countries have an incentive to ignore their pollution „exports“. The percentage share of international upstream-downstream river basins where more reported monitoring takes place in the downstream than the upstream country exhibits a sharp increase over time, but is small in absolute terms (less than five percent).

Besides this upstream-downstream effect we observe geographic effects associated with the size of a basin: more monitoring data is reported for larger basins across the three samples. Also, reporting is less intense when the share of agricultural landuse is higher. In contrast to

[12] This is precisely the aim of (public) EEA reports that assign smileys and frowneys to each country.

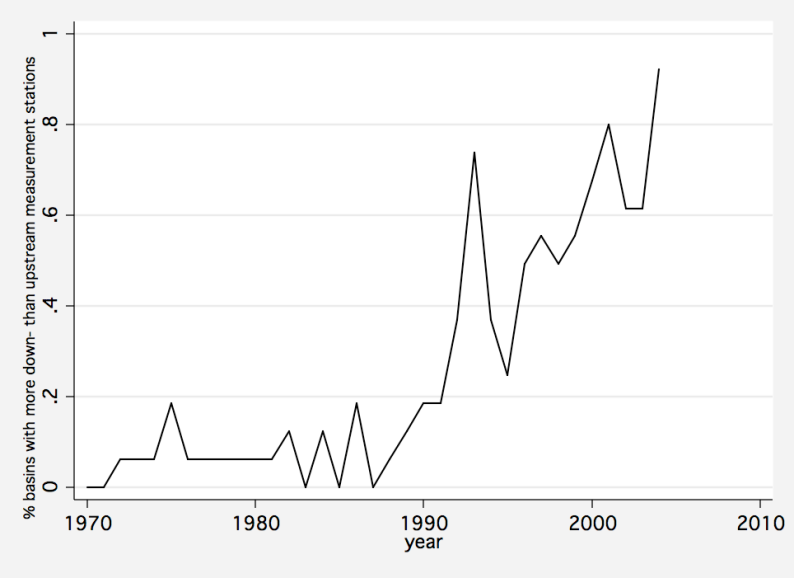

Figure 5.5: *Monitoring downstream and upstream*
(The sample on which this figure is based includes boundary-crossing (upstream-downstream) international water systems. On the vertical axis we measure the percentage of international upstream-downstream basins where there are more active monitoring stations located upstream than downstream.)

the finding for population density (more reported monitoring in basins with higher population density, see hypothesis 7) this finding for agricultural landuse suggests that reporting may be negatively affected by strategic considerations – more agriculture is usually associated with higher levels of water pollution by nutrients. However, the positive effect of population density is more robust than the negative effect of agricultural landuse (see below), so that, overall, hypothesis 7 is weakly supported by the evidence.

The time trend effect is significant and positive in all three models, reflecting more reporting over time. The year dummies for selected years suggest that in the run-up to the Water Framework Directive, which entered into force in the year 2000, participation in the EEA reporting process weakened. One interpretation is that at least some countries experienced capacity constraints in trying to meet both the EEA reporting requirement and the new WFD reporting requirements.

Finally, we have examined whether our main results are sensitive to changes in the statistical approach and whether results differ when we use a dyadic rather than a monadic set-up. With two minor exceptions, which in fact turn out to offer more rather than less support for our hypotheses, the main results pertain when employing a different statistical approach (see tables 7, 8 and 9 in the appendix). First, when we use a quasi-maximum likelihood approach, trade openness becomes statistically significant and positive. This result, in contrast to the results produced by our main models, supports hypothesis 4. Second, the coefficient on agricultural landuse is not robust across different specifications.

In an additional robustness check, we take into account bilateral relations between country-pairs (i.e. dyads) to assess whether variables capturing joint riparian characteristics (i.e. joint

membership in international organisations or bilateral trade interdependencies) have an effect on monitoring behavior (see Table 10 in the appendix). In contrast to the results for our principal models, the effects of both joint IGO membership and agricultural land-use become positive, which supports our theoretical expectations. The effect of membership in global environmental regimes, in turn, is statistically significant and negative. Other monadic results (namely those that are consistent across samples and in accordance with our theoretical expectations) survive in the dyadic set-up.

5.6 Conclusion

Describing and explaining the location and nature of water quality monitoring can offer important insights into environmental policy priorities and behavior at national and international levels. Water quality data, on which this paper has focused, is important not only for diagnostic purposes when designing policies. It is also highly relevant for implementing national and international water policies. Assuming that monitoring behavior is unlikely to follow a strictly ecological or human health oriented logic, we have tested several hypotheses that seek to account for temporal and spatial clustering of reported monitoring activity. Our explanatory framework relies on a combination of domestic and international factors.

It turns out that domestic factors, particularly income and democracy, have consistently positive effects on monitoring. International factors, notably income-related peer group behavior, trade openness, and involvement in international organizations and global environmental regimes, have weaker effects than we expected. We did not find evidence for beggar-thy-neighbor behavior in monitoring: even though monitoring intensity is higher in international upstream-downstream settings, we were not able to identify a bias towards more monitoring in downstream countries; and the results for most explanatory variables do not differ much across samples including domestic or international stations. In contrast to what we expected, EU membership has a consistently negative effect on monitoring; and while monitoring activity increased over time, it decreased in the run-up to the Water Framework Directive (in force since 2000).

Some of our results may be reason for concern. Adherents of the liberal institutionalist school of international politics tend to assume that countries that are more involved in international policy-making networks should be more cooperative also in terms of monitoring and data reporting. We could not find robust evidence for this claim. On the contrary, the effects of membership in international organizations are negative or statistically insignificant. The same holds for the effect of trade openness. Moreover, EU membership has a statistically significant, negative effect in all models.

Other results convey a more positive picture. Income and democracy have the expected positive, independent effects. Moreover, population density has a statistically significant, positive effect on monitoring in all models. To the extent population density can serve as a proxy for environmental pressure, and looking at it from an environmental policy perspective, more extensive monitoring in river systems exposed to greater environmental pressure is certainly desirable.

Our findings have two types of practical implications. First, international coordination and standardization of environmental monitoring should be intensified, and those who aggregate locally produced environmental data into national averages or use such averages for scientific research or policy-making should be alert to potential biases, such as the ones studied in this paper. International agencies, such as the EEA, UNEP, OECD, or World Bank should invest much more in standardizing and controlling data quality as well as naming, but also helping countries that perform poorly in environmental monitoring and data reporting. The EEA, for example, has taken some, albeit still very gentle, steps in this direction by publishing reports that rate the quality of countries' environmental monitoring and reporting behavior. Similar efforts are being undertaken by the EU in the context of implementing Article 8 (which asks for improved monitoring) of the Water Framework Directive.

The second implication is that more research on how international environmental datasets are generated and what the potential biases are is urgently needed. Further research in the specific area studied in this paper should concentrate on at least three issues.

The negative effect of EU membership and the negative time-effect in the run-up to the Water Framework Directive (WFD) require further study. Systematic surveys of national water management or environmental authorities will be required to establish whether this effect is due to negligence once countries have made it into the EU, whether the WFD exerts a crowding out effect on the EEA's monitoring network, or whether other causes are responsible for the observed effect.

The analysis could be expanded to look not only at the location of monitoring activity, but also at what types of pollutants are measured, and how frequently. It will be very interesting to examine whether the findings reported in this paper are similar when studying the specific contents of data reporting. Ideally, such research could also establish what data from what location and at what time-intervals would have to be collected and reported in order to generate a truly representative or accurate picture – from an ecological and public health viewpoint – of national or aquatic system-specific environmental performance.

The research reported in this paper may, at first glance, look somewhat narrow in scope, but it directs attention to a much larger issue. Scientists have invested very heavily in describing and explaining environmental performance in international comparison. It would be great if they could also invest some time in reflecting in depth on how the data they use is generated, whether there are systematic biases in existing datasets and processes through which they are constructed, and explore ways and means of mitigating such biases.

Electronical Sources

Bredahl, L. and A. Sousa (2006): European River Catchments, Version 1.01. Copenhagen: European Environment Agency, December 2006, `http://www.eea.europa.eu/data-and-maps/data/european-river-catchments`, date accessed: 10.12.2009.

EEA (2007a): European Environment Agency: Waterbase - Rivers, `http://www.eea.europa.`

eu/data-and-maps/data/waterbase-rivers-5, date accessed: 10.12.2009.

EEA (2007b): European Environment Agency, The Water Information System for Europe (WISE), http://water.europa.eu/en/welcome, date accessed: 10.12.2009.

EEA (2007c): European Environment Agency: Corine land cover 2000 (CLC2000) seamless vector database., http://www.eea.europa.eu/data-and-maps/data/corine-land-cover-2000-clc2000-seamless-vector-database-1, date accessed: 10.12.2009.

Eionet, European Environment Information and Observation Network, http://www.eionet.europa.eu/, date accessed: 10.12.2009.

ESRI Geoinformatik AG: http://esri-suisse.ch/index.html, date accessed: 10.12.2009.

Eurostat (2008): Statistical Database of the European Commission, http://epp.eurostat.ec.europa.eu, date accessed: 10.12.2009.

Heston, A., Summers, R. and Aten, B. (2006). Penn World Table Version 6.2: Center for International Comparisons of Production, Income and Prices at the University of Pennsylvania, September 2006, http://pwt.econ.upenn.edu/php_site/pwt_index.php, date accessed: 10.12.2009.

Landscan (2005): Landscan 2005 Global Population Dataset, http://www.ornl.gov/sci/landscan/index.html, date accessed: 10.12.2009.

Marshall, M. G. and K. Jaggers (2004): Polity IV Project: Political Regime Characteristics and Transitions, 1800-2004, http://www.systemicpeace.org/polity/polity4.htm, date accessed: 10.12.2009.

Mitchell, T. D., Carter, T. R., Jones, P. and M. Hulme (2003): A Comprehensive Set of High-Resolution Grids of Monthly Climate for Europe and the Globe: The Observed Record (1901-2000) and 16 Scenarios (2001-2100). Journal of Climate, Data access: http://csi.cgiar.org/cru/index.asp, date accessed: 10.12.2009.

Owen, T., K. Furlong and N. P. Gleditsch (2004): Codebook for The Shared River Basin GIS and Database, www.prio.no/cscw/envi/rivers/, date accessed: 10.12.2009.

Pevehouse, J., T. Nordstrom and K. Warnke (2004): Intergovernmental Organizations. 1815-2000: A New Correlates of War Data Set, http://www.correlatesofwar.org/Datasets.htm, date accessed: 10.12.2009.

The Center for International Earth Science Information Network (CIESIN): http://www.ciesin.org/, date accessed: 10.12.2009.

The United Nations Global Environment Monitoring System (GEMS) Water Programme: http://www.gemstat.org/, date accessed: 10.12.2009.

The United Nations Global Environment Outlook Data Portal: http://geodata.grid.unep.ch/ date accessed: 10.12.2009.

UNSTAT (2008): Statistical Yearbooks. New York: United Nations Statistics Division, http://unstats.un.org/unsd/demographic/products/dyb/dyb2.htm, date accessed: 10.12.2009.

Vogt, J. et al. (2003): CCM River and Catchment Database, Version 1.0. European Commission: DEG Joint Research Centre. http://agrienv.jrc.ec.europa.eu/publications-ECpubs.htm, date accessed: 10.12.2009.

Vogt, J. et al. (2007a): Developing a pan-European Database of Drainage Networks and Catchment Boundaries from a 100 Metre DEM. European Commission: DEG Joint Research Centre, http://agrienv.jrc.ec.europa.eu/publications-ECpubs.htm, date accessed: 10.12.2009.

Wolf, A.; L. de Silva; N. Eidern and P. MacQuarrie (2005): Transboundary Freshwater Dispute Database, http://www.transboundarywaters.orst.edu/, date accessed: 10.12.2009.

Chapter 6

A Comparison of International and Domestic Sources of Global Governance Dynamics

Thomas Bernauer, Anna Kalbhenn, Vally Koubi, Gabi Ruoff

British Journal of Political Science, forthcoming

Abstract:

Existing empirical models of international co-operation emphasize domestic determinants, even though virtually all theories of international relations pay a great deal of attention to interdependencies among countries. We contribute to restoring the balance between theory and empirical analysis by examining the extent to which linkages of states with the international system influence the dynamics of global governance efforts, relative to domestic factors such as income and democracy. To that end, we study the ratification behaviour of 180 countries vis-à-vis 255 global environmental treaties in the time-period 1950-2000. With the exception of integration into the world economy, which affects cooperative behaviour and the evolution of global environmental governance negatively, the results show that international factors have a stronger, and positive, impact on cooperative behaviour than domestic factors. The main implication is that heeding to Galton's advice not to examine the effects of unit-internal and unit-external variables in isolation is useful also in the study of international politics.

6.1 Introduction

In this paper we examine to what extent linkages of states with the international system and with each other influence international co-operation, relative to domestic factors such as income and democracy. Conventional wisdom among analysts of international affairs holds that foreign policy behaviour of countries, and by implication also international co-operation and global governance efforts, are influenced both by unit-internal (domestic) and unit-external (international) factors. Moreover, virtually all theories of international relations pay a great deal of attention to interdependencies among countries, and interdependent decision-making in particular (Axelrod 1997, Keohane & Nye 1977). And yet, there is a surprising disconnect between this widely shared view and empirical models of international co-operation. Large-N empirical models in particular emphasize domestic determinants. They pay only scant attention to how pre-existing linkages of a country with the international system more broadly affect cooperative behaviour in specific cases, and how one country's behaviour is affected by the behaviour of other countries (Hafner-Burton et al. 2008). This paper addresses this imbalance between theorizing on the implications of interdependence in the international system and the empirical analysis of international co-operation.

Empirically, we are interested in the factors that motivate countries to ratify international treaties. In particular, we study the effects of country-external and country-internal determinants of international co-operation side-by-side, thus viewing ratification behaviour through the lens of Galton's problem (Jahn 2006*b*)[1].We thereby focus on global environmental agreements, that is, agreements that are open to ratification to all countries globally. Environmental issues have over the past three decades moved from the realm of low politics into the mainstream of the global policy agenda. This development is, for example, reflected in the portfolios of virtually all institutional heavyweights in the international system – from the World Trade Organization and the World Bank to the OECD and the European Union. It is also reflected in increasing mass media attention to international environmental problems, such as climate change.

The international environmental politics literature has grown enormously, with ever more detailed and sophisticated case study work illuminating the causes of environmental problems, the problem solving mechanisms, and the determinants of success or failure in solving these problems (Mitchell 2002). While the (single or comparative, small-N) case study work, which thus far dominates the field, is highly insightful and important there is also a need for more macro-level, quantitative research that examines the "large picture".

International environmental treaties per se do not solve problems of environmental degradation (Haas et al. 1993, Bernauer 1995, Siegfried & Bernauer 2007, Young 1999, Sprinz & Helm 2000, Mitchell 1994). But they are key elements in virtually all efforts to build international governance systems (regimes) for such purposes and are thus often a precondition for solving environmental problems. Only very few studies have examined the factors that motivate countries to enter into legally binding environmental commitments at the international level (Frank 1999, Neumayer 2002*b*,*a*, Murdoch et al. 2003, Roberts et al. 2004, von Stein 2008). Most

[1] In 1889, Sir Francis Galton argued that cultural similarities could be due to evolutionary development, but also due to common descent and borrowing. He also argued that explanations that did not take into account all these possibilities could arrive at false conclusions. In our case these driving forces can be conceptualized in terms of country-internal characteristics and country-external factors.

work of this kind concentrates on specific international agreements.

Von Stein (2008) studies the Framework Convention on Climate Change and the Kyoto Protocol and the challenge of designing mechanisms that 'deter defection without deterring participation'. She finds that with harder to meet obligations countries become more selective about ratification. Her results also suggest that flexibility mechanisms may to some extent help in addressing this dilemma, and that domestic and international networks have fostered ratification of the Framework Convention, but not the Kyoto Protocol.

Murdoch et al. (2003) study treaty participation as a two-stage game in which states first decide on whether to participate (ratification stage) and then they decide on their level of participation (implementation stage). They argue that a country's behaviour should differ between the ratification stage, when co-operation and binding commitments by others are important considerations, and the implementation stage, when strategic considerations regarding own efforts of compliance dominate. They test their argument with data on 25 countries that ratified the Helsinki Protocol (an agreement on air pollution in Europe). They find that reduced emission imports resulting from reductions abroad promote treaty ratification by the beneficiary country, whereas that very same explanatory variable also increases free-riding at the implementation stage – in the latter case other countries' emission reductions substitute for one's own efforts beyond the mandated reductions.

Neumayer (2002*b*) examines ratification behaviour with respect to several international environmental treaties, postulating that trade openness promotes multilateral environmental cooperation. He finds some, albeit weak evidence in support of this hypothesis, suggesting that ratification depends on how the respective agreement affects specific interests in exporting countries. In a closely related paper, Neumayer (2002*a*) studies whether democracies exhibit stronger international environmental commitment than non-democracies. Focusing on treaties for endangered species, biodiversity, and ozone layer protection, he finds evidence that democracies join more multilateral environmental agreements and intergovernmental environmental organizations, and that they perform better with respect to reporting requirements under the Convention on International Trade in Endangered Species of Fauna and Flora. Neumayer (2002*a*, 139) concludes that '. . . a spread of democracy around the world will lead to enhanced environmental commitment worldwide'.

Congleton (1992) and Fredriksson & Gaston (2000) examine the Montreal Protocol and the Framework Convention on Climate Change respectively and find that democracies are more likely to ratify these agreements. Similarly, Fredriksson & Ujhelyi (2006) observe that democracy and environmental lobby groups have a positive effect on the ratification of international environmental agreements. In contrast to these studies Murdoch et al. (2003), in their study on the Helsinki Protocol, find that democratic countries are less likely to ratify this treaty but are likely to make bigger efforts at the implementation stage. Zilbauer (2005) studies ratification delays in five environmental agreements as a function of democracy and presence of environmental lobby groups. He finds that 'democracy as well as environmental pressure group strength tend to reduce ratification delay in four out of five agreements [...] However, one treaty exhibits reverse effects, indicating that the relationship cannot be generalized on all international environmental problems alike' (Zilbauer 2005, 5).

Roberts et al. (2004) carry out a cross-sectional study of the determinants of ratification rates of 22 international environmental treaties by 177 countries in 1946-1999. They find that most variance in environmental treaty ratifications is explained by "disadvantaged insertion into the world economy" (defined in terms of a narrow export base), voice and accountability through domestic institutions, and civil society pressure (number of NGOs in the country) – all three variables have a positive effect. The authors conclude '...the number of NGOs in a nation appears virtually synonymous with its likelihood to participate in environmental treaties' (Roberts et al. 2004, 39). Similarly, Frank (1999) seeks to explain the number of international environmental treaties ratified by a country in four time-periods: 1900-1945, 1946-1962, 1963-1972, and 1973-1990. He finds that a country's linkages to world society (measured by membership in international non-governmental science and/or environmental associations) is the strongest predictor of ratification.

These studies of international environmental commitments offer important insights. But their findings leave room for further research. First, they are based on very small samples of international environmental treaties or individual treaties (partial exceptions are Frank 1999, Roberts et al. 2004). Second, their empirical design is (with the exception of von Stein 2008, Zilbauer 2005) cross-sectional and does not consider temporal dynamics. Third, and most important for this paper, the driving forces examined are largely domestic, whereas the recent literature on international co-operation suggests that cooperative behaviour vis-à-vis international governance systems is likely to be shaped also by pre-existing linkages of states with the international system and by how *other* states behave in the area of concern (Jahn 2008, Simmons et al. 2006, Simmons & Elkins 2004, Ward 2006).

In this paper we add to the existing literature in several ways. First, unlike previous studies we examine unit-external *and* unit-internal driving forces of international co-operation side-by-side and systematically compare their (relative) importance. Moreover, unlike previous studies we examine the effects of two distinct types of unit-external factors: political and economic integration into the international system broadly defined, and contingent behaviour. The latter illuminates the extent to which ratification behaviour of any given country is affected by whether other countries, or specific other countries ratify.

Second, we use a much larger sample than previous studies to test our hypotheses. Our dataset covers global environmental treaty ratifications in the time-period 1950-2000 (approximately 180 countries and 255 global environmental treaties over 50 years).

Third, we use a novel empirical research design – with treaty-country pairs over time as the unit of observation. This research design permits analysis of the spatial and temporal evolution of international environmental co-operation, which is particularly important when analyzing contingent (interdependent) ratification behaviour of countries. The data analysis relies on a binary-times-series-cross-sectional (BTSCS) approach as proposed by Carter & Signorino (2009).

With the exception of integration into the world economy, which affects cooperative behaviour negatively, the results show that international factors have a stronger and positive impact on ratification behaviour than domestic factors, such as democracy and income.

Our findings have important analytical and policy implications. They demonstrate that taking interdependencies in the international system seriously, not only in theoretical work but also in empirical models of international co-operation, increases the explanatory value of such models. Heeding to Galton's advice not to examine the effects of unit-internal and unit-external variables in isolation turns out to be useful also in the study of international politics. Further research should find out whether our results uphold in other policy-areas, or whether, for particular theoretical reasons, we should expect the effects of international linkages to vary across issue-areas.

From a policy perspective, our findings suggest that ratification dynamics are important and offer room for pro-active policies that promote global governance efforts. While it is obviously difficult to boost income, democracy and other co-operation-promoting domestic factors in laggard countries in the short to medium term and at acceptable cost, our results demonstrate that countries interested in the effective formation of global governance systems can positively influence laggard country behaviour by moving ahead with ratification. Our results suggest that "entangling" reticent countries in more international organizations can also be helpful in promoting the formation of specific global governance systems.

The following section develops the theoretical arguments and hypotheses to be tested. We then describe the data and methods used and present the results of the empirical analysis before concluding with a discussion of the implications of our findings.

6.2 Theory

We are primarily interested in the extent to which linkages of states with the international system and with each other influence international co-operation – in our case the ratification of global environmental treaties – relative to domestic factors. Therefore, we first conceptualize international linkages in terms of political and economic integration of countries into the international system as well as contingent behaviour and present a set of hypotheses on the effects of these unit-external factors. While our arguments on the effects of integration into the international system pertain to relatively amorphous influences that result from being part, in varying degrees, of the "international community", contingent behaviour views ratification choices as being influenced by the behaviour of specific other states in the same issue-area. In a second step, we then turn to unit-internal factors and present arguments on how democracy and income are likely to influence countries' ratification behaviour.

6.2.1 Linkages of States with the International System

Although the term globalization has been very prominent in political discourses since the early 1990s, its connotations vary a lot across scientific disciplines, individual studies, and policy contexts. For instance, while many economists define globalization somewhat narrowly as the international integration of markets in goods, services, and capital, others stress cultural homogeneity and "harmonization of economic institutions" (Drezner 1998). International political economy (IPE) scholars in particular devote much attention to institutionalized efforts

to increase international co-operation among states in issue areas ranging from economic (e.g., trade) to social (e.g., illicit human trafficking) to security (e.g., terrorism) to environmental (e.g., climate change) issues. States indeed often commit to a particular course of action by joining international treaties on a variety of issues, thus signaling some convergence in economic, social, and environmental thinking and practice. That is, the very fact that states are to an increasing extent seeking and implementing international or even global solutions to transboundary problems can serve as an indicator of globalization. Consequently, in this paper we define linkages of states with the international system (and by implication with each other) in a broad sense as involving both political and economic integration into the international system.

6.2.1.1 Involvement in international organizations

With regard to international political integration we assume that countries that are already "entangled" in a larger network of international organizations – for example the Bretton Woods institutions and specialized agencies of the UN system – are more likely to adopt this cooperative behaviour also in other issue areas and with regard to other forms of international co-operation. Our argument postulates, therefore, that more extensive membership in international organizations (IOs) motivates states to behave more cooperatively also when it comes to forms of international co-operation that lie outside the scope of specific international organizations they have joined at some prior time.

It is important to recognize the differences between international organizations and global environmental treaties, the specific form of international co-operation we are interested in. To be recognized as an international organization, an organization needs to be highly institutionalized, which is reflected, for example, in the fact that IOs possess a permanent secretariat and hold regular meetings (Pevehouse et al. 2004*a*). This implies that IOs constitute the most formalized way of international co-operation. In addition, IOs are set up to deal with a variety of issues that are usually not connected to environmental topics. In contrast, to be counted as an international treaty the only requirement that needs to be fulfilled according to the 1969 Vienna Convention on the Law of Treaties is that the agreement is 'an international agreement concluded between States in written form and governed by international law' in which states express 'consent to be bound' (Aust 2000). Hence, multilateral environmental agreements are usually less institutionalized compared to international organizations and they are by definition limited in their scope to environmental topics.

However, both international organizations and multilateral treaties allow states to coordinate their behaviour and thereby achieve benefits from mutual co-operation (Keohane 1984). Consequently, we argue that membership in international organizations signals a general willingness of states to behave cooperatively in international matters, which states may also carry over to other, very particular issue areas such as environmental policy.

Liberal institutionalism posits that under conditions of interdependence, uncertainty and high transaction costs states establish international organizations to facilitate co-operation. That is, IOs, by increasing information and decreasing transaction costs and uncertainty, facilitate international negotiations on new agreements or revision of existing ones, and they reduce the risk of opportunism in implementing international commitments (Keohane 1984, Haas et al. 1993,

Mitchell 1994, Abbott & Snidal 1998). More generally, IOs are assumed to move states away from pursuing relative gains and towards positive-sum outcomes, help them overcome collective action problems, and promote shared interests (Young 1994, 1999). In addition, they specify legitimate ways for states to handle domestic and international issues (Meyer et al. 1997), encourage effective interstate bargaining (Boehmer et al. 2004), and assist states in solving complex technical problems in more efficient ways (Mitrany 1966, Haas 1964). Membership in IOs thus signals a government's general willingness to cooperate internationally and adopt rules and regulations that benefit other countries as well.

Although rational states choose to participate in international environmental agreements only when they estimate that the benefits accrued to them by implementing a particular treaty will be larger than the benefits of unilateral efforts, failure to ratify a treaty could lead to reciprocal actions by other states that would undermine the collective effort (Axelrod & Keohane 1986).[2] Reciprocity becomes even more important if we take into account that countries interact in many issue areas at the same time and that these issues are linked. For example, when a country fails to ratify an environmental treaty it may have to worry about other countries' refusal to ratify, say, a trade agreement. Moreover, being a member of several IOs but refusing to cooperate in the realm of international environmental co-operation may entail "audience costs" in terms of credibility and reputation losses at home and abroad (Simmons 1993, Mercer 1996). As noted by Simmons (1993), credibility has become essential to successful resolution of some of the most important issues states face today, such as environmental degradation. We assume that such effects tend to grow in importance with growing IO membership of a country also because many IOs deal with a wide variety of issues and can thus establish more linkages across issues.

The arguments outlined in the previous paragraph are likely to be of special importance in the field of environmental co-operation. Environmental protection and thus also ratification of multilateral environmental treaties means that countries have to forego certain benefits in other areas such as economic growth. Consequently, low-income countries in particular may often not be willing to join such treaties. However, if these countries are already entangled in a larger network of international organizations it may be possible to "get them on board" through issue linkages, assistance, reciprocal action or reputational mechanisms. Recent research in fact shows that membership in international organizations and environmental international non-governmental organizations (EINGOs) plays an important role in environmental protection policies of less developed countries (Ruoff 2009*b*, Jorgenson 2009*a*,*b*).

In summary, the "entanglement" argument relies both on liberal institutionalist and on what one might call sociological assumptions. Greater involvement in international organizations fosters cooperative behaviour by reducing transactions costs and creating opportunities for diffuse reciprocity. It also has a "socialization" effect in terms of creating norms of appropriateness. Hence, being a member of international organizations in general might lead governments to value the more generic benefits of international co-operation and thus to adopt this cooperative behaviour to very different issue areas and with regard to different forms of international co-operation.

H1: Countries that are more involved in international organizations are more likely

[2] Axelrod and Keohane (1986: 250) state that 'International regimes do not substitute for reciprocity; rather they reinforce and institutionalize it, ... delegitimizing defection and thereby making it more costly.'.

to join international environmental agreements.

6.2.1.2 Integration in the world economy

The impact of trade on the environment has been the subject of an extensive and controversial debate in both political and academic circles. Moreover, it is amenable to relatively coherent theoretical arguments and empirical testing. This is why, in examining the effects of countries' integration into the world economy, we focus on trade effects.[3]

Neumayer (2002*b*), relying mainly on arguments commonly associated with the "liberal peace" and arguments pertaining to reputation, coercion, and signaling, posits that trade openness promotes participation in multilateral environmental agreements (MEAs). However, his empirical findings provide only weak statistical support for this hypothesis and he partly retracts by stating '[...] countries' willingness to cooperate in MEAs depends on whether the MEA under consideration is likely to threaten or accommodate the interests of exporters' (Neumayer 2002*b*, 831). Prakash & Potoski (2006) examine participation rates in ISO 14001, a widely used environmental certification system under which firms can voluntarily subscribe to certain standards of green behaviour. They find 'that trade linkages encourage ISO 14001 adoption if countries' major export markets have adopted this voluntary regulation' (Prakash & Potoski 2006, 350). In contrast, Beron et al. (2003) and Wagner (2008), in studies on the Montreal Protocol, find that trade interdependence had no significant effect either on ratification or its timing.

Studies such as these offer important insights into whether and how economic integration affects environmental policy in general and environmental treaty ratification in particular. But these insights remain vulnerable to three types of criticism. First, virtually all studies focus on one or very few environmental policy areas; thus it remains open whether their findings can be generalized across a wider range of environmental policy issues.

Second, to explain co-operation almost all existing studies rely on the "liberal peace" argument, which postulates that trade between two states increases the economic costs of war for both participants and consequently reduces the probability of conflict (Oneal & Russett 1999, Gartzke 2008, Barbieri n.d.).[4] However, we think that the "liberal argument" is not appropriate for the examination of ratification behaviour because decisions on whether to ratify an environmental treaty depend heavily on domestic considerations concerning the effects on one's own competitiveness. Our argument on the effect of trade on multilateral environmental treaty ratification thus follows standard trade theory.

Third, the positive effect of trade observed for ISO 14001 is closely connected to the trading-up argument (Vogel 1997). This argument holds that greener jurisdictions can "export" their preferences and standards to other countries via trade relationships. However, the trading-up effect is likely to materialize only under quite narrowly defined conditions. In a country-to-country context, the principal trading-up mechanism – market access restrictions for polluting goods

[3] We are aware that international economic integration is not limited to international trade, and that capital and labor mobility might be as important; but we leave their analysis to future research.

[4] Katherine Barbieri (2002) however, finds that more trade leads to more conflict. See Schneider et al. (eds) 2003 for a survey of the literature.

imposed by the importing country – operates primarily with respect to the environmental properties of products (e.g., cars with or without catalytic converters; that is, product regulation), but to a much lesser extent with respect to production processes (Bernauer & Caduff 2004). Many international environmental issues, e.g. climate change mitigation or marine oil pollution, concern production processes rather than the properties of internationally traded products. We posit that a closer look at standard trade theory is necessary, and that this should make us rather skeptical about optimistic (trading-up) views on the effect of trade on international environmental co-operation.

According to standard trade theory (H-O), trade leads to more production of goods that are intensive in the factor that is abundant in the country concerned. Consequently, comparative advantage derives from the distribution of world endowments of the factors of production (the factor endowment theory). If this assumption is correct, developed countries, which are more capital abundant, may become 'dirtier' with free trade because capital-intensive production tends to cause more pollution. Therefore, controlling for other influences (e.g., income, democracy) they will be more reluctant to participate in international environmental agreements that hamper their comparative advantage in the production of polluting goods (regulatory chill effect). If, however, the comparative advantage derives from policy related differences across countries in tolerance of pollution (the pollution haven or risk shifting hypothesis), then the less developed countries, which tend to be more labor than capital abundant, are likely to be more reluctant to engage in international environmental co-operation. That is, we should then expect poorer countries to engage in more polluting production as a function of growing international trade due to the pollution haven effect; hence they should also be more reluctant to ratify environmental agreements that hurt their comparative advantage which derives from laxer environmental regulation.

Depending on whether the factor endowment or pollution haven effect dominates, richer or poorer countries will, for competitiveness reasons, be more reluctant to join international environmental agreements. Consequently, we expect negative trade effects on average because both the factor endowments and the pollution haven effect push in this direction. In other words, the more intensively a country trades, the greater the loss from a reduction in trade. Environmental regulation increases the costs of producing exportables and it thus reduces exports (i.e., it acts like a tax on exports). Consequently, the trade-off between gains from a cleaner environment and losses from lower exports is more adverse for more open economies.

> **H2:** Countries that trade intensively are less likely to join international environmental agreements.

6.2.1.3 Contingent behaviour

Decisions by countries on whether to ratify international agreements are most probably influenced by what other countries do in the respective policy area. In other words, nations pay attention to or even mimic their peers (Simmons et al. 2006). In view of the large game theoretic and institutionalist literature on international co-operation this claim may sound almost trivial. Surprisingly, however, large-N empirical research on international co-operation has –

perhaps because it is so obvious – not paid much attention to contingent behaviour.

An exception is the recent research, primarily under the label of "policy diffusion", that has started to explore the role of contingent behaviour more systematically (Elkins et al. 2006, Simmons et al. 2006, Meseguer 2005, 2006, Levi-Faur 2005, Elkins & Simmons 2005, Henisz et al. 2005, Simmons & Elkins 2004). Simmons et al. (2006, 787) define diffusion as follows: 'International policy diffusion occurs when government policy decisions in a given country are systematically conditioned by prior policy choices made in other countries (sometimes mediated by the behaviour of international organizations or even private actors or organizations)'. Most studies take several diffusion mechanisms into account. For example, Elkins et al. (2006) find that coercion and competition play a role in the spread of bilateral trade agreements. Simmons & Elkins (2004) report that both competition and learning matter for economic liberalization. Henisz et al. (2005) observe that coercion, common norms and competition contribute to spread of market-oriented reforms. Simmons (2000) finds evidence that countries are more likely to make and honor a legal agreement such as the IMF's Article VIII[5] if their neighbor countries are doing so.

Even though all of the above mentioned mechanisms may play a role in motivating states to ratify international environmental treaties, we suspect that most of them are quite highly correlated and also shaped by other factors that we regard as determinants of ratification behaviour (e.g., trade openness, democracy, income). We believe that it is reasonable to assume that all of the aforementioned mechanisms are at work more prominently in cases where countries share some common characteristics, such as same level of economic development and location in the same geographic region. In other words, we argue that any given country's ratification behaviour is influenced by ratification behaviour in its "peer group".

Our study thus contributes to the increasing literature that addresses what is known as Galton's problem. As outlined above Galton's problem points to the difficulty of accounting for whether a government makes a specific policy choice because a specific cause or event impacting on all countries or on a given pair or group of countries, for example pressures arising from globalization, forces it to do so, because of unit-internal characteristics, or because this government follows (e.g. through learning or competition) the specific policy choice of another government with whom it shares some common characteristics. By differentiating between contingent behaviour, effects of international political and economic integration, and effects of domestic driving forces of treaty ratification, the approach taken in this paper takes into account Galton's problem.

Our hypotheses identify peer group effects in three forms:

> **H3a:**The propensity of a country to join an international environmental agreement increases with the number of other countries that have joined this agreement.

> **H3b:**The propensity of a country to join an international environmental agreement increases with the share of other countries in the same geographic region that have joined this agreement.

[5] Article VIII prohibits restrictions on a country's current account (Simmons 2000: 820).

H3c: The propensity of a country to join an international environmental agreement increases with the share of other countries in the same income bracket that have joined this agreement.

Whereas the last three sections have discussed the effects of unit-external or international driving forces we now turn to unit-internal or domestic determinants of countries' ratification behaviour.

6.2.2 Domestic Factors

Most of the recent literature on international co-operation and international environmental politics in particular views both income and democracy as factors that promote co-operation. Hence we conceptualize these two variables as the two domestic (unit-internal) factors in reference to which we assess the effects of international linkages and relegate other variables to the status of control variables.

6.2.2.1 Income

The existing environmental politics and economics literature concentrates on the effect of income on environmental quality (pollution) rather than treaty ratification behaviour. Translation of its arguments on the income-pollution relationship to ratification behaviour is straightforward, however, because we can assume that countries that are more willing to improve their environmental quality are also more willing to join international treaties in this realm.

The large body of theoretical and empirical literature that focuses on economic determinants of environmental quality has led to the identification of an important empirical pattern, the so-called environmental Kuznets curve (Selden & Song 1994, Grossman & Krueger 1995). Many (but not all) forms of environmental degradation first become worse and then improve as income per capita increases. The turning points of the curve vary considerably across pollutants and countries. The standard interpretation of this pattern is that environmental quality is a luxury good in the initial stages of socio-economic development. Poor countries facing a trade-off between protecting the environment and improving material living standards opt for the latter. Once significant gains have been made in living standards, the opportunity cost of stricter environmental policies becomes (relatively) smaller and constituencies are prepared to accept lower economic or personal income growth (the two may not be identical) to obtain less pollution. That is, environmental quality becomes a 'normal' good. Assuming that this pattern applies not only to local, but also to transboundary environmental goods, and that international treaties are a necessary (though not sufficient) condition for achieving improvements in environmental quality, we expect that a country's willingness to ratify an international environmental treaty is positively correlated with income. The empirical analysis will examine both linear and non-linear income effects.

6.2.2.2 Democracy

Many authors have argued that democratic countries are more likely to make credible international policy commitments than their non-democratic counterparts (Fearon 1994, Gaubatz 1996, Leeds 1999, Martin 2000, Mansfield et al. 2002). The reasons are that democratic institutions are stronger compared to non-democracies, democratic decision-makers are more accountable vis-à-vis their electorate, audience costs in democracies are higher, and so is transparency. This implies that democratic dyads are more likely to be able to solve transboundary problems through mutual international commitments.[6] We cannot directly deduce from this argument, however, that (in a monadic sense) democratic countries are more likely to join international agreements. We submit, nonetheless, that democracy is likely to have a positive effect on participation in international environmental agreements, but the reasons are somewhat different from the aforementioned ones. Arguments relating democracy and international environmental commitment can be grouped into demand and supply side arguments (Baettig & Bernauer 2009).

As to the demand side, democratic political systems offer a much higher degree of civil liberties, such as freedom of speech, press and association (Payne 1995). Such liberties imply that citizens are better informed by independent mass media and other sources (e.g., NGOs) about environmental problems and government policies. They also have more opportunities to express freely their opinions and organize around alternative political views, and thus they can impose higher audience costs on policy-makers who renege on promises (Slantchev 2006). Consequently, at any given level of (objective) environmental risk exposure and/or income, public demand by the median voter and/or politically influential interest groups for risk mitigation is likely to be stronger in democracies than in non-democracies. That is, our expectation is that the higher the level of civil liberties, the higher the probability that a country ratifies an environmental treaty.

As to the supply side, many authors have argued that non-democratic political systems are likely to under-provide public goods, including environmental quality (For example Congleton 1992, Olson 1993, McGuire & Olson 1996, Niskanen 1997, Lake & Baum 2001, Bueno de Mesquita et al. 2003, Bernauer & Koubi 2009). They are typically governed by small elites that use the resources of their country to generate personal wealth and funnel income from the population into their own pockets. If the costs of stricter environmental policies mandated by an international environmental treaty fall disproportionately on the governing elites in the sense of opportunity costs from spending tax revenue on environmental protection instead of accumulating rents while the benefits are uniformly dispersed throughout the population (e.g., cleaner air), then these elites would have little incentive to ratify this treaty. Conversely, the median voter in a democracy incurs lower marginal cost from environmental policies relative to the economic and political elite in non-democracies (Bernauer & Koubi 2009).

Congleton (1992) argues, however, that a short time horizon of policy makers may lead to less stringent environmental regulation. Many forms of environmental degradation in fact develop slowly and over long periods of time (e.g. climate change, biodiversity loss, air and water

[6] Kalbhenn (2009), for example, shows that democratic pairs of countries tend to cooperate more in international river management issues compared to non-democratic or mixed dyads. See also Thomas Bernauer and Patick Kuhn (2009).

pollution). Hence their mitigation requires a long time horizon. Assuming that authoritarian rulers tend to have a shorter time horizon, we can conclude that democracies enact stricter environmental regulation than non-democracies. But quite the reverse, one might also argue that elected governments have shorter planning horizons than non-elected governments because of political myopia (maximizing votes at the next election).[7] Since the social costs of current economic behaviour and political choices often materialize only over the long term and burden future generations and future politicians, democratic leaders may refrain from ratifying international environmental treaties that impose high short-term costs. Their autocratic counterparts, in contrast, do not face democratic elections and can take more costly decisions (stricter environmental policies) with longer term benefits without fear of been punished by myopic voters. Consequently, democracies might be less willing to ratify international environmental treaties.

Overall, public demand for environmental risk mitigation is likely to be stronger in democracies than in non-democracies (demand side). Whether democratic political elites are more inclined to satisfy such demand than non-democratic elites remains an empirical question. The existing literature has, thus far, found mainly positive effects (See, for example Neumayer 2002*a*, Zilbauer 2005, von Stein 2008, Bernauer & Koubi 2009, Baettig & Bernauer 2009). Even though these studies concentrate on one or very few international environmental agreements, we follow those findings and expect (albeit with caution) that more democratic countries are more likely to ratify international environmental agreements.

6.2.3 Control Variables

6.2.3.1 Power

We expect that power, defined in terms of a country's economic size and/or population, has a significant although theoretically ambiguous effect on ratification behaviour. Neumayer (2002*a*, 150), for instance, argues that powerful states are more likely to participate in multilateral environmental agreements '...in order to demonstrate their importance in world politics, of which the environment represents one part. In other words, important countries want to be seen as good citizens and leaders in world environmental affairs.' This is only one possibility, and even in this case we suspect that participation is likely to be motivated primarily by countries' concerns for their own safety and well-being, rather than the desire to be seen as good world citizens by someone else. The other, not so glamorous possibility is that more powerful states may choose not to ratify because they are likely to get away with such behaviour at lower cost.[8] In other words, the effect of power is theoretically ambiguous, but potentially important. We control for this effect without a prior assumption concerning its direction.

[7] Bueno de Mesquita et al. (2003), empirically show that once autocratic leaders succeed in surviving in office during the initial years of seizing power then they survive in office longer than their democratic counterparts (chapter 7).

[8] The failure of the USA to ratify the Kyoto Protocol is a good example.

6.2.3.2 Domestic environmental quality

Countries' willingness to participate in international environmental agreements may reflect the degree to which environmental degradation impinges upon their national welfare. Sprinz & Vaahoranta (1994) argue that 'the worse the state of the environment, the greater the incentives to reduce the ecological vulnerability of the state.' If we subscribe to this argument, we should expect that countries with bigger domestic pollution problems are more likely to join international environmental agreements because there is greater public demand for more stringent environmental policies, and/or because the government seeks to tie its hands through international commitments in order to be able to impose stricter policies on opposing domestic interests. In addition, we may also expect that states whose environmental quality is improving or has improved as the result of strict domestic environmental regulation are likely to face lower domestic political and economic hurdles in ratifying international environmental commitments. However, given that more polluted countries also face higher abatement costs, it is reasonable to assume that these costs might deter governments from ratifying a cost imposing treaty. Consequently, we expect domestic environmental quality to have an ambiguous effect on ratification behaviour.

6.2.3.3 Geographic region

Whereas hypothesis H3b (see above) focuses on the effect of regional ratification behaviour in terms of contingent behaviour, we also include regional dummy variables to capture any effects that the geographical location of a country might have on its propensity to ratify an agreement. For the empirical analysis, we select from the very large number of international environmental agreements only those that are, in principle, open to all countries globally. However, some agreements may, because of the very nature of the issue they deal with, attract more countries from some regions than from others. For example, African countries might be less eager to join agreements to protect arctic seals and polar bears (even though these agreements are open to them), whereas many Western European countries may be less interested in efforts to cope with desertification.

6.3 Empirical Analysis

We test the above hypotheses with a new panel dataset covering 180 countries' ratification behaviour (ratification[9]: yes/no) towards international environmental treaties from 1950 to 2000. The unit of analysis is the treaty-country pair per year. Each treaty enters the dataset at the moment when it becomes open for ratification and is then paired with all countries that existed at this particular point in time. Hence, in contrast to the more common country-dyad approach we do not pair countries with other countries but countries with treaties. Each treaty-country pair stays in the dataset until the year when the respective country ratifies the treaty. For each year we estimate the probability of a particular country ratifying a treaty, as described in section

[9] In this paper, we use the term "ratification" to indicate any form of binding commitment (as opposed to signature). Depending on the specific legal context, this commitment can also be expressed by adhesion, accession, etc.

6.3.2. This approach allows us to include both country and treaty specific characteristics. In this paper, the term treaty specific characteristics relates to any condition that varies across treaties, but not across countries. We proceed by first defining the variables used in the analysis and then discussing the statistical method. The empirical part concludes with the presentation and discussion of the results.

6.3.1 Variables

The following paragraphs briefly describe the data used. Tables 6.1 and refT2 provide descriptive statistics for all variables and the web appendix contains more detailed descriptive statistics for the dependent (ratification) variable.

6.3.1.1 Dependent variable

The dependent variable is defined in terms of the ratification of a multilateral environmental treaty. We coded ratification in binary form. For each year in which a treaty is not ratified by a particular country the respective treaty-country pair is coded as zero (0). The dependent variable takes the value one (1) in the year the country ratifies the treaty, whereupon this particular treaty-country pair leaves the dataset. The latter approach is necessary because leaving the treaty-country pair with code 1 in the dataset after ratification would indicate that the respective country ratified the treaty again and again in each subsequent year until 2000 (where our dataset ends). The data on treaties and ratifications was retrieved from the datasets by CIESIN (2006) and Mitchell (2002-2008*b*). We then eliminated from this data treaties that, in our assessment, are not environmental treaties or deal with environmental issues only at the margin, and treaties that are not open to all countries globally; and we re-coded the remaining data to fit the particular format used for this analysis. Our dataset includes 255 treaties[10]. Whether particular treaties are not only in principle but also de facto open to all countries globally is not entirely clear in some cases. We have thus assessed the robustness of our statistical findings with alternative sample compositions (presented in the web appendix).

6.3.1.2 Independent variables

11

Involvement in international organizations: IO membership Membership in international organizations (IO) is measured by the number of IOs of which a country is a member in any given year. The data is taken from the Correlates of War project (Pevehouse et al. 2004*a*). This project's IO dataset offers three distinct variables differentiated according to whether a state has full, associated or observer membership. In our principal models we use the most inclusive

[10] The number of treaties that has been ratified by a country varies between 132 in the case of France or 126 in the case of Great Britain and 9 in the case of Somalia or only 8 in the case of Bhutan.

[11] The correlation coefficients are shown in the web appendix.

(or least "stringent") variable, the one that includes full, associated and observer membership. We check the robustness of the results by using both the most narrowly defined variable, which includes only full membership, and the variable that includes full membership and observer status. Altogether, the Correlates of War project identifies 495 international organizations. The mean number of memberships per country is around 50 with Great Britain having the maximum number of memberships, 134.

Integration in the world economy: trade intensity We measure a country's trade intensity by the ratio of the sum of exports and imports to GDP. The data is taken from Gleditsch (2002), Heston et al. (2006).

Contingent behaviour To test contingent behaviour effects we have created several variables. For hypothesis H3a, we use a variable measuring the total number of states in the international system that have already ratified the particular treaty. Similarly, we include two variables measuring the percentage of countries from the same geographical group (region) and the percentage of countries from the same income group that have already ratified the particular treaty (hypotheses H3b and H3c). Geographic regions are defined according to the IIASA world population program[12] definition. Following World Bank standards, we categorize countries into three income groups: low-income countries with a GDP per capita below 3,273 USD, middle-income countries with a GDP between 3,273 and 11,115 USD per capita, and high-income countries with a GDP per capita above the latter amount. We use a one-year lagged value of all contingency variables. We also include dummy variables for the most powerful (in terms of economic size and/or population) countries in the system.

Income: log value of GDP per capita A country's wealth is measured by the log value of GDP per capita. The data is taken from Gleditsch (2002). As discussed in the theory section, income may also have a non-linear effect on the likelihood of ratifying international environmental treaties. We thus include also the squared value of the log of GDP per capita.

Democracy (demand side): civil liberties We use the civil liberties component of the Freedom House Index to test whether more civil liberties increase the likelihood of ratifying global environmental treaties. The Freedom House organization rates all countries of the world on dimensions of political and civil rights. The civil liberties part of the index measures constraints, among other things, on: association and organizational rights (freedom of assembly, demonstration, political or quasi-political organizations including ad hoc issue groups, and free trade unions and farmers organizations); the rule of law and human rights (existence of an independent judiciary, and freedom from extreme government indifference and corruption); and personal autonomy and economic rights (secured property rights, personal social freedoms, and equality of opportunity including freedom from exploitation by or dependency on employers,

[12] http://www.iiasa.ac.at/Research/POP/proj01/countries.html The regions are: Centrally Planned Asia, Central Asia, North Africa, Middle East, Sub Saharan Africa, Latin America, Western Europe, Eastern Europe, North America, Pacific OECD, South Asia, Former Soviet Union, Pacific Asia.

union leaders or bureaucrats). Freedom House rates countries on a 1 to 7 scale. In countries with a rating of 1, law is unshaken and there is freedom of expression, assembly, and association. Increasing numbers indicate that laws and traditions impinge increasingly on such freedoms until, in states ranked as 7, citizens have no rights vis-à-vis the state and '... an overwhelming and justified fear of repression characterizes these societies' (FreedomHouse 2008). To facilitate intuitive interpretation, we transform the variable so that a higher value means a higher level of civil liberties (7 now represents the highest level of civil liberties).

Democracy (supply side) Supply side features of democracy are measured with an index capturing the extent of democratic participation in government. We use a composite index from the POLITY IV data set that includes the following elements: presence of competitive political participation, guarantees of openness and competitiveness of executive recruitment, and existence of institutionalized constraints on the exercise of executive power. Polity ranges from –10 (most autocratic) to 10 (most democratic) (Jaggers & Gurr 1995, Marshall & Jaggers 2002). We check the robustness of our results by using Vanhanen (2000a)'s democracy index as well as Freedom House's Political Rights Index[13].

6.3.1.3 Control variables

Power: log of population, log of GDP To control for the effect of power we use two variables: the log value of the population of a country, for which we use data from the Correlates of War data set of national military capabilities (Singer et al. 1972) and the log value of GDP, that is the economic size of a country (Gleditsch 2002). Since both variables are highly correlated we include only one of them in any model and use the other for a robustness check.

Domestic environmental quality: log of SO_2 emissions per capita Because there exists no composite index of domestic environmental quality for many countries and years we rely on the log of SO_2 emissions per capita as a proxy (Stern 2005). We use this admittedly crude proxy because SO_2 emissions are, arguably, the most common form of air pollution and a very common target of environmental policy in most countries.

Region We include dummy variables for world regions to control for specific features of environmental treaties that may attract countries from one region more than others. The regions are Eastern Asia, Western Asia, Africa, Latin America, Europe, and North America.[14]

[13] The political rights element of the Freedom House Index, which is very close to the Polity IV measure of democracy, captures mainly the fairness and freedom of elections, that is, whether a government came to power by election or by non-democratic means; whether elections, if any, are free and fair; and whether an opposition exists and has the opportunity to take power with the consent of the electorate.

[14] We have used a more differentiated definition of regions to assess contingency effects (see above). The regional dummies are defined in broader terms because their main goal is to control for any remaining effects on treaty ratification that may emanate from a less clearly defined set of geographic or ecological factors.

Table 6.1: *Summary statistics continuous variables*

		Mean	Std. Dev.	Min	Max	Observations
ln trade intensity	overall	-15.76	1.06	-25.12	-12.56	N = 681,227
	between		0.92			n = 43,524
	within		0.54			$\bar{T}$ = 15.65
Democracy (Polity)	overall	-0.015	7.38	-10	10	N = 625,904
	between		6.67			n = 40,475
	within		3.6			$\bar{T}$ = 15.46
Civil liberties	overall	3.95	1.92	1	7	N = 666,711
	between		1.81			n = 47,495
	within		0.79			$\bar{T}$ = 14.04
Political rights	overall	3.98	2.24	1	7	N = 666,711
	between		2.1			n = 47,495
	within		0.98			$\bar{T}$ = 14.04
Mean of cilvil lib. + political rights	overall	3.97	2.04	1	7	N = 666,711
	between		1.93			n = 47,495
	within		0.822			$\bar{T}$ = 14.04
id	overall	10.61	12.35	0	47.08	N = 677,315
	between		12.15			n = 43,486
	within		5.12			$\bar{T}$ = 15.58
IO membership	overall	50.74	20.74	0	134	N = 662,850
	between		20.45			n = 43,305
	within		9.44			$\bar{T}$ = 15.31
ln GDP p.c.	overall	8.17	1.07	5.64	10.74	N = 681,227
	between		1.07			n = 43,524
	within		0.21			$\bar{T}$ = 15.65
ln GDP p.c.^{2}	overall	67.86	17.68	31.8	115.3	N = 681,227
	between		17.7			n = 43,524
	within		3.54			$\bar{T}$ = 15.65
ln SO_2 p.c.	overall	3.44	2.41	-4.42	9.58	N = 678,871
	between		2.35			n = 44,011
	within		0.64			$\bar{T}$ = 15.43
# of other countries that ratified	overall	17.2	21.66	0	180	N = 870,158
	between		19.32			n = 55,254
	within		11.54			$\bar{T}$ = 15.75
% of same income group that ratified	overall	8.03	12.73	0	100	N = 681,227
	between		9.81			n = 43,524
	within		6.95			$\bar{T}$ = 15.65
% of countries in region that ratified	overall	5.26	12.62	0	100	N = 870,158
	between		10.71			n = 55,254
	within		6.02			$\bar{T}$ = 15.75
aget	overall	13.59	10.98	0	50	N = 870,158
	between		8.38			n = 55,254
	within		7.93			$\bar{T}$ = 15.75
GDP	overall	162,000,000,000	583,000,000,000	276,000,000	9,170,000,000,000	N = 681,227
	between		628,000,000,000			n = 43,524
	within		164,000,000,000			$\bar{T}$ = 15.65
t	overall	13.59	10.98	0	50	N = 870,158
	between		8.38			n = 55,254
	within		7.93			$\bar{T}$ = 15.75
t^2	overall	305.21	422.35	0	2,500	N = 870,158
	between		290.45			n = 55,254
	within		309.49			$\bar{T}$ = 15.75
t^3	overall	8,540.25	16,470.73	0	125,000	N = 870,158
	between		10,733.73			n = 55,254
	within		12,407.67			$\bar{T}$ = 15.75

Table 6.2: *Frequencies dummy variables, percentages in parenthesis*

Ratification	862,474	(99.12)	7,684	(0.88)
Africa	638,936	(73.43)	231,222	(26.57)
North America	862,538	(99.12)	7,620	(0.88)
Latin America	729,696	(83.86)	140,462	(16.14)
East Asia	773,973	(88.95)	96,185	(11.05)
West Asia	765,333	(87.95)	104,825	(12.05)
UK	470,067	(54.02)	400,091	(45.98)
US	638,805	(73.41)	231,353	(26.59)
Germany	493,968	(56.77)	376,190	(43.23)
Spain	503,248	(57.83)	366,910	(42.17)
France	469,718	(53.98)	400,440	(46.02)
Russia	629,378	(72.33)	240,780	(27.67)
Brazil	756,270	(86.91)	113,888	(13.09)
China	785,452	(90.27)	84,706	(9.73)
India	753,521	(86.60)	116,637	(13.40)

6.3.2 Statistical Method

The unit of analysis is the country-treaty pair per year. That is, for each year in which a given treaty is open for ratification, it is paired with all potential member countries, so that each observation is formed by a particular treaty, the country that may or may not have ratified the treaty, and the year this action did or did not take place[15]. A treaty-country pair leaves the dataset in the year after the country has ratified the treaty, i.e. after the dependent variable has changed from zero to one. By combining all multilateral environmental treaties in one dataset we introduce some heterogeneity between the treaties in our analysis. We deal with this issue of unit heterogeneity in several ways that are described in the section on robustness checks below.

Since we are dealing with a binary outcome variable (ratification; yes/no) we rely on the approach proposed by Carter & Signorino (2007), which is similar to the binary-time-series-cross-sectional (BTSCS) approach described in Beck et al. (1998). This approach views BTSCS data as grouped duration data in which the interval of observing the data is fixed to one year. Hence, this approach is analogous to a survival analysis, the difference being that the dependent variable in the BTSCS framework is observed yearly, whereas many survival models are designed for continuous time. We cross-checked our results using a complementary log-log model, which is equivalent to a proportional hazard model for interval censored (i.e. grouped duration) data. The results do not differ substantively and are presented in the web appendix. To model temporal dependence, time as well as its squared and cubic term (t, t^2 and t^3) are included in the models. This approach acknowledges that a country's ratification behaviour today depends strongly on its ratification behaviour in the years before and thus controls for time effects.[16] The use of t, t^2 and t^3 (cubic time polynomial) instead of cubic splines (which is

[15] In only very rare circumstances a country withdraws from a treaty it has already ratified. If this is the case, the particular country-treaty combination is reintegrated into the dataset.

[16] In addition to the inclusion of t, t^2 and t^3, we test the robustness of our results by including time dummies and decade dummies. The decade dummies are a possibility to control for changing environmental consciousness over time and thus constitute an additional approach to dealing with time dependence in our model. The corresponding results can be found in the web appendix.

recommended by Beck et al. 1998) has the advantage of a more straightforward interpretation of the baseline hazard, whereas the approximation of the baseline hazard is at least as good as with cubic splines (Carter & Signorino 2007). To assess the robustness of our results we also use alternative statistical techniques (the results are presented in the web appendix).

The timeframe of our analysis ranges from 1950 to 2000. Although we have treaty ratification data for the time-period before 1950 and after 2000 this is not the case for most independent variables. In some models that include variables such as the civil liberties index of Freedom House the time-period is further reduced.

6.3.3 Results

Table 6.3 reports the results from the regression of treaty ratification on the explanatory variables described above.

The first column in Table 6.3 shows the results of our principal explanatory model.[17] The evidence supports hypotheses H1 and H2: IO membership has a statistically significant positive, and trade has a statistically significant negative effect on ratification behaviour. As to the hypothesized contingent behaviour effects, our results show that the number of countries that previously ratified a given treaty significantly increases the likelihood that any other country will also ratify that treaty (hypothesis H3a). The same holds true for the share of countries in a given country's region that previously ratified the treaty (hypothesis H3b). In contrast, the share of countries in a given country's income group that previously ratified the treaty has no statistically significant effect (hypothesis H3c). The latter result suggests that geographically defined contingency effects are stronger than income-related contingency effects. Except for the number of countries per income group all unit-external variables are therefore significantly related to the likelihood of treaty ratification.

This is also the case when we turn to the unit-internal effects. Both democracy and income affect countries' ratification behaviour positively. To visualize the non-linear effect of income, Figure 6.1 shows the effect of the log of GDP per capita on the likelihood of treaty ratification while all other variables are kept at their mean levels[18]. It indicates that countries with a higher GDP per capita are more likely to ratify international environmental treaties, but it also shows that the overall effect of GDP per capita is rather small.

As to the control variables, power has a negative effect. That is, the more powerful a country is – measured in terms of GDP – the less likely it is to ratify a treaty. Thus, more powerful countries, rather than trying to become environmental role models, appear to be able to get away with less cooperative behaviour. The negative effect persists when we use population instead of GDP to measure a country's power.

The effect of the domestic environmental quality variable, proxied by SO_2 emissions per capita,

[17] All models were estimated using robust standard errors clustered by countries to control for the fact that observations for the same country may be more similar than observations across different countries.

[18] To provide a better intuition we have included in the web appendix the same figure using GDP per capita instead of the log of GDP per capita.

Table 6.3: *Principal Models*

	(1)	(2)	(3)	(4)	(5)
IO membership	0.01***	0.01***	0.01*	0.01*	0.01***
	(0)	(0)	(0)	(0)	(0)
ln trade intensity	-0.12**	-0.12**	-0.09	-0.1	-0.13**
	(0.05)	(0.05)	(0.06)	(0.06)	(0.06)
Number of other countries that ratified	0.02***	0.02***	0.02***	0.02***	0.02***
	(0)	(0)	(0)	(0)	(0)
Per cent of same income group that ratified	0	0	0	0	0
	(0)	(0)	(0)	(0)	(0)
Per cent of countries in region that ratified	0.03***	0.03***	0.03***	0.03***	0.03***
	(0)	(0)	(0)	(0)	(0)
Democracy (Polity)	0.02***	0.01*	-	-	0.01*
	(0.01)	(0.01)			(0.01)
Political rights	-	-	-0.07**	-	-
			(0.03)		
Civil liberites	-	-	0.18***	-	-
			(0.04)		
Mean of civil lib. + political rights	-	-	-	0.07***	-
				(0.02)	
ln GDP p.c.	1.04*	0.93	1.07**	0.89	0.71
	(0.58)	(0.62)	(0.54)	(0.57)	(0.62)
ln GDP p.c.^{2}	-0.04	-0.04	-0.05*	-0.04	-0.02
	(0.04)	(0.04)	(0.03)	(0.03)	(0.04)
ln SO_2 p.c.	0.12***	0.09***	0.09***	0.09***	0.09***
	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
ln GDP	-0.10*	-0.07	0.02	-0.01	-0.06
	(0.06)	(0.07)	(0.07)	(0.07)	(0.07)
Africa	-	-0.51***	-0.44***	-0.43***	-0.48***
		(0.15)	(0.14)	(0.14)	(0.15)
North America	-	-0.55***	-0.73***	-0.67***	-0.59***
		(0.16)	(0.21)	(0.2)	(0.15)
Latin America	-	-0.54***	-0.49***	-0.49***	-0.53***
		(0.12)	(0.12)	(0.12)	(0.12)
East Asia	-	-0.46***	-0.50***	-0.48***	-0.46***
		(0.14)	(0.14)	(0.15)	(0.14)
West Asia	-	-0.71***	-0.61***	-0.63***	-0.71***
		(0.16)	(0.15)	(0.16)	(0.16)
UK	-	-	-	-	0.17***
					(0.06)
US	-	-	-	-	0.20***
					(0.06)
Germany	-	-	-	-	0.14**
					(0.06)
Spain	-	-	-	-	0.22*
					(0.06)
France	-	-	-	-	0.1
					(0.06)
Russia	-	-	-	-	0.08
					(0.06)
Brazil	-	-	-	-	-0.08
					(0.07)
China	-	-	-	-	0.29***
					(0.09)
India	-	-	-	-	0.31***
					(0.06)
t	-0.33***	-0.33***	-0.31***	-0.31***	-0.38***
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
t^2	0.01***	0.01***	0.01***	0.01***	0.01***
	(0)	(0)	(0)	(0)	(0)
t^3	-0.00***	-0.00***	-0.00***	-0.00***	-0.00***
	(0)	(0)	(0)	(0)	(0)
Constant	-9.92***	-9.39***	-11.34***	-10.28***	-8.98***
	(2.55)	(2.97)	(2.5)	(2.64)	(2.96)
Observations	574,196	574,196	574,547	574,547	574,196

Note: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

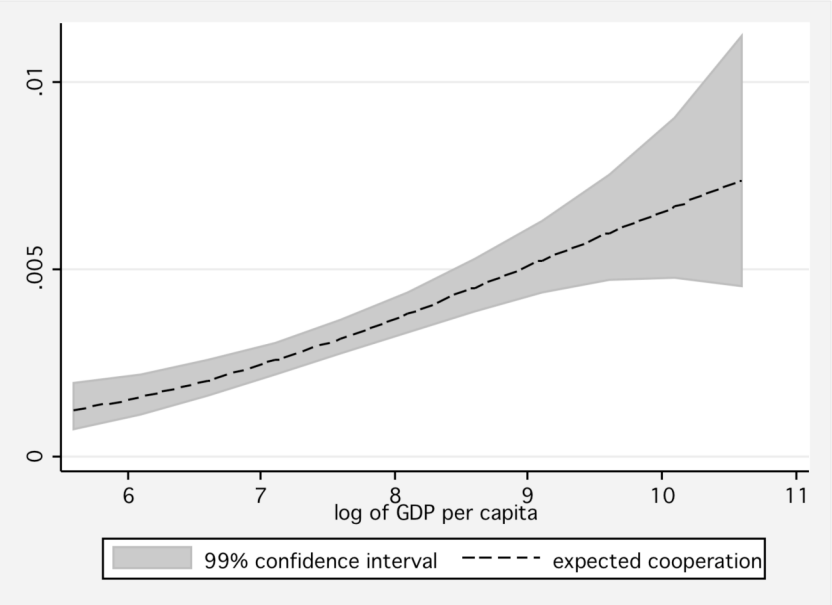

Figure 6.1: *Effect of log GDP p.c. on the likelihood of treaty ratification*
Note: all other variables are kept at their means.

is positive and significant: the higher the SO_2 emissions per capita, the more likely a country is to ratify global environmental agreements. This result should be interpreted with caution because the proxy we use is a very crude one. Nonetheless, there are two potential interpretations that could be examined in more detail in future research. One is that governments of countries exposed to greater environmental damage use global environmental agreements to tie their hands vis-à-vis opposing domestic constituencies. The other is that governments of such countries use global environmental agreements to purchase international good will and improve their reputation, particular if their environmental behaviour generates transboundary externalities (which is often the case with SO_2 emissions).

In column 2 of Table 6.3 the principal model is extended to include regional dummy variables. Compared to the base category, which is Europe, countries located in any of the other regions are less likely to ratify global environmental treaties as is indicated by the negative and statistically significant coefficients. In columns 3 and 4 of Table 6.3 we evaluate the effect of democracy in more detail. When we use the civil and political rights variables from Freedom House (column 3), we obtain a different picture from the one shown in column 1 in which we used the Polity IV index to measure democracy. We observe that more civil liberties increase the probability of joining a global treaty. In contrast to the results in column 1, more political rights decrease a country's propensity to ratify. When both civil and political rights are combined into one variable the positive effect prevails (column 4 in Table 6.3).[19] These results suggest that in sum democracies tend to be more willing to join international environmental treaties. However,

[19] Although political rights and civil liberties, as measured by Freedom House, are highly correlated, they capture distinct phenomena. For example, some countries score lower on civil rights than on political rights (e.g. Italy, Argentina and Colombia) and others score higher on civil liberties than political rights (e.g. Peru and Brazil). In any event, high correlation between the two variables does not cast doubt on our findings because multicollinearity does not bias coefficients. It only increases standard errors, which makes it harder to obtain statistically significant results.

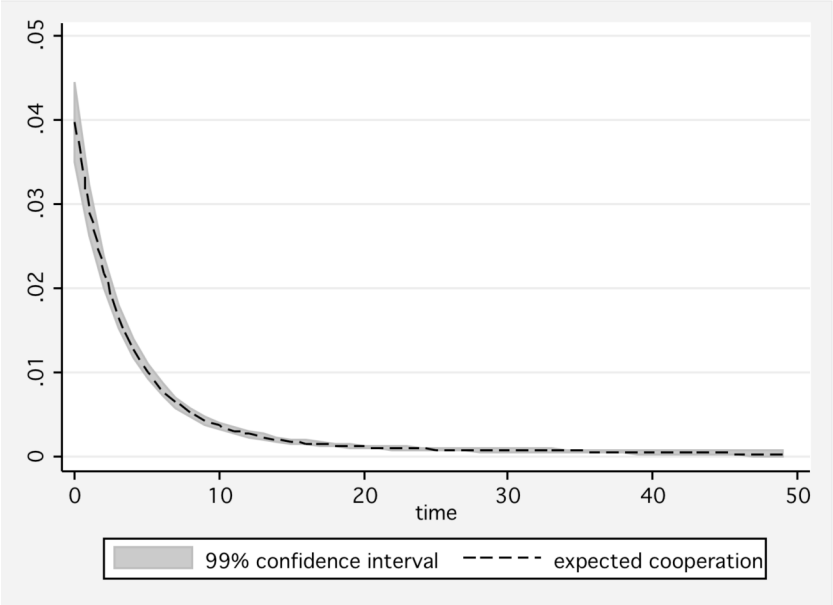

Figure 6.2: *Likelihood of treaty ratification over time*
Note: all other variables are kept at their means.

the effect appears to be mostly due to the demand side of the political system as civil liberties allow citizens to pressure their governments to behave more cooperatively at the international level. The supply side of democracies, the political rights, does not seem to promote international environmental co-operation. This result is in line with the results of studies that find positive effects of civil society pressure (which can be regarded as a demand side indicator) on environmental treaty ratifications (e.g. Roberts et al. 2004, Frank 1999).

The last column in Table 6.3 shows the results of a model that includes dummy variables indicating whether important countries have already ratified a given treaty. It indicates that prior ratification by countries such as China, Germany, and the UK has a positive effect. The effect is most pronounced for India, and least important and insignificant for France, Russia and Brazil.[20] In other words, our results show that powerful countries are less likely to ratify, but once they do this motivates other countries to join as well.

The statistical approach used in this paper also allows us to obtain an estimate of time dependence[21] underlying treaty ratification behaviour in our sample. Figure 6.2 indicates the likelihood of treaty ratification as a function of t, t^2 and t^3 while all other variables are kept at their mean levels. The figure shows that the baseline hazard is strongly decreasing with time. That is, the probability of ratification by any given country is higher shortly after a treaty is opened for ratification and then decreases over time.

To obtain a better intuition of the estimated relationships between our main independent vari-

[20] We also tested the effect of ratification by important countries with a dummy variable indicating whether the particular country is a major power (based on the Correlates of War data). This variable has no significant effects in our models – see web appendix.

[21] Using a likelihood ratio test we examined whether there is time dependence in our model. The test clearly rejected the model without t, t^2, t^3 (LR $\chi^2(3) = 7977.55$; Prob > $\chi^2 = 0.00$).

ables and the propensity of treaty ratification we simulated predicted probabilities.[22] The results are shown in Table 6.4[23]. They are based on the principal model shown in column 1, Table 6.3. The predicted probabilities displayed in Table 6.4 clearly indicate that the effects of international factors are stronger than the effects of domestic factors. It should be noted in this context that the size of the effects we compare is independent of potential multicollinearity between domestic variables.

Table 6.4: *Simulated Probabilities, Principal Model*

Simulated Probability Pr(ratification=1)	Mean to Max	Min to Mean	Min to Max
IO membership	0.007	0.002	0.009
	(0.003)	(0)	(0.003)
ln trade intensity	-0.001	-0.004	-0.006
	(0)	(0.003)	(0.003)
Number of other countries that ratified	0.136	0.001	0.137
	(0.053)	(0)	(0.053)
Per cent of same income group that ratified	-0.001	0	-0.001
	(0.001)	(0)	(0.001)
Per cent of countries in region that ratified	0.08	0.001	0.081
	(0.017)	(0)	(0.017)
Democracy (Polity)	0.001	0.001	0.002
	(0)	(0)	(0.001)

Note: Standard errors in parentheses; all other variables are kept at their mean values.

The first column of Table 6.4 shows changes in probabilities of treaty ratification if the explanatory variable concerned changes its value from the mean to the maximum. Columns 2 and 3 indicate changes in the propensity of treaty ratification for changes of the explanatory variable from the minimum to the mean and from the minimum to the maximum. Interestingly, the effects of the contingent behaviour variables, except for the ratification share in the same income group, are much stronger than the effects of democracy and income[24]. For example, a change from full autocracy (Polity IV value of -10) to full democracy (Polity IV value of 10) increases the probability of ratification by 0.2 per cent. In contrast, if the share of ratifiers in a country's region changes from the mean to the maximum, this increases the probability of ratification by 8 per cent. Similarly, a change from the mean number of IO memberships, which is 50, to the maximum number of 134 produces an increase in the ratification probability by 0.7 per cent.

Furthermore, Table 6.4 shows that except for trade intensity all effects are stronger when the explanatory variable changes from its mean to its maximum value compared to a change from its minimum to its mean value. This indicates that there are potential threshold effects: if only some countries in a region have ratified a given treaty the likelihood for another country in

22 The simulation 'results were obtained using CLARIFY (Tomz et al. 2001, King et al. 2000)

23 To further illustrate the effects of our main independent variables we have created graphs that plot the likelihood of treaty ratification over the whole range of the independent variable in question while all other variables are kept at their mean values. These figures can be found in the web appendix.

24 Since we include both GDP per capita and its square term in the regression we use Figure 6.1 to illustrate the overall effect of GDP per capita on treaty ratification. From this figure we can deduce that the change in probabilities from the minimum to the maximum level of GDP per capita is smaller than for the contingent behavior variables such as number of other countries that have ratified the treaty.

this region to ratify this treaty does not increase much. However, if already a larger number of countries in a region have ratified the likelihood of ratification for the remaining countries in this region increases quite strongly.

To illustrate what our results imply "in reality", we calculated predicted probabilities for specific country characteristics, using the USA, China, Switzerland, Morocco, and Costa Rica as examples. All country specific variables such as trade or democracy were set to the value the particular variable took in the year 2000 for the respective country. All treaty specific variables such as the number of countries that had already ratified the treaty were set to their mean values. Table 6.5 shows the predicted probabilities as well as the values for which they were calculated. For example, the probability that the USA ratifies any given treaty based on its trade, democracy score, IO membership, air pollution and income in the year 2000 turns out to be 1.4 per cent. This probability is somewhat higher compared to Switzerland for which the probability of treaty ratification is predicted to be 0.8 per cent, and much higher compared to China, Morocco, and Costa Rica for which the probability is predicted to be 0.5 per cent.

In absolute terms, the probabilities shown in Tables 6.4 and 6.5 appear to be very small. But it needs to be borne in mind that treaty ratifications are rare events (only 0.88 per cent of all observations are coded as 1), so that probabilities of treaty ratification estimated by any statistical model are automatically very small. In other words, the effects of IO membership and the contingent behaviour variables, which are proxies for linkages of countries with their external environment, are in fact very substantial.

6.3.4 Robustness Checks

We have checked the robustness of our results in various ways. For a start, we have examined whether particular specifications of the main explanatory variables affect the results. Various measures for IO membership, democracy, power and trade are used to that end. To assess whether our results are sensitive to the estimation method, we re-estimated the model using different econometric approaches, checked whether the fact that ratification is a rare event influences the main results, accounted for right-censoring, and controlled for potential unit heterogeneity in various ways. We have also evaluated whether the inclusion of additional control variables changes the results. Furthermore, we have used different definitions of what is to be considered a global environmental treaty and re-estimated the principal model for the resulting samples. Finally, we revisited the results for the trade variable to examine whether they might be disproportionately influenced by those countries that trade intensively or only very little. Our main results are robust to all these alterations (the results of all robustness checks are presented in the web appendix).

6.4 Conclusion

In this paper we have examined the extent to which linkages of countries with their external environment (unit-external factors) affect global governance dynamics, relative to domestic level determinants (unit-internal factors). We conceptualized such linkages in terms of a country's

Table 6.5: *Simulated Probabilities, Country Examples*

Country	Simulated probability Pr(ratification=1)	Democracy	ln(trade intensity)	IO membership	GDP p.c.	SO_2 p.c.	GDP (in hundred thousands)
USA	0.014	10	-15.34	93	33,292.92	7,420.49	9,169 648
	(0.002)						
Switzerland	0.008	10	-13.96	93	26,413.75	9	189,755
	(0.001)						
Morocco	0.005	-6	-15.52	84	3,716.70	140.82	106,350
	(0.001)						
China	0.005	-7	-15.77	74	3,747.30	9,975.51	4,706,662
	(0.001)						
Costa Rica	0.005	10	-14.34	76	5,861.85	1.79	22,348
	(0.001)						

Note: Robust standard errors in parentheses; all other variables are kept at their mean values.

involvement in international organizations of any type, its integration into the world economy, and contingent behaviour. The empirical focus is on global environmental co-operation. We hypothesized that involvement in international organizations and contingency variables have a positive effect on global environmental co-operation, and that economic integration into the world economy has a negative effect. The empirical testing was done on a sample of 180 countries and approximately 255 multilateral environmental treaties over 50 years (1950-2000). The most important empirical finding is that, overall, international factors have a stronger effect on cooperative behaviour (in the form of treaty ratification) than domestic factors, such as income and democracy.

The main implication of our findings for research on international co-operation and institutions is that linkages of states with their external environment should receive greater attention, both at the theoretical and empirical level. Explanatory models of cooperative behaviour of states in the international realm have become increasingly sophisticated in specifying the domestic drivers of such behaviour. But they have paid rather little attention to the fact that international co-operation is a complex process in which any given country's behaviour is also shaped by the extent to which it is embedded in the international system, and by how specific other countries behave. Our results demonstrate that explanatory models of international co-operation that ignore international linkages may be misspecified. This conclusion, in general terms, is very much in line with conclusions that have recently emerged from the literature on policy-diffusion and international networks (Ward 2006, Braund & Gilardi 2006, Dorussen & Ward 2008, Shipan & Volden 2008).

The empirical results reported in this paper are based on the analysis of global environmental governance efforts. We are quite confident, however, that the analysis of international cooperative behaviour (as indicated by treaty ratifications) in other policy areas is likely to produce similar findings. Our empirical approach may serve as a useful template for such research. Further research could also move beyond the rather simple IO membership variable and focus on more sophisticated indicators for the position of countries in international political/institutional networks (Ward 2006). And it could include more detailed control variables pertaining to treaty characteristics.

The main policy implication is that the existing literature may be too optimistic about the co-operation-promoting effects of wealth, democracy, and trade. Countries' decisions on whether or not to participate in global governance efforts may be influenced in larger measure by their general involvement in international organizations of any type, and by what other countries do in the same policy area. This conclusion is in fact quite encouraging. It implies that there is considerable room for pro-active policies that promote global governance efforts. Our results show that countries interested in the effective formation of global governance systems can positively influence laggard country behaviour by moving ahead with ratification. They also suggest that "entangling" reticent countries in more international organizations of any type can be helpful in promoting the formation of specific global governance systems.

6.5 Appendix

6.5.1 Additional Descriptive Statistics

The main dataset contains 255 treaties opened for ratification between 1950 and 2000.

Table 6.6 shows the baseline hazard of ratification, which is the conditional probability of ratification given that a certain country has not yet ratified the treaty, for different years a treaty is open for ratification. We can deduce that – assuming the same baseline hazard for every treaty – the baseline ratification hazard is .018 in the year the treaty is opened for ratification, .023 in the first and the second year after ratification, etc. We can see that the baseline hazard gradually declines over time.

Figure 6.3 visualizes the baseline hazard displayed in Table 6.6.

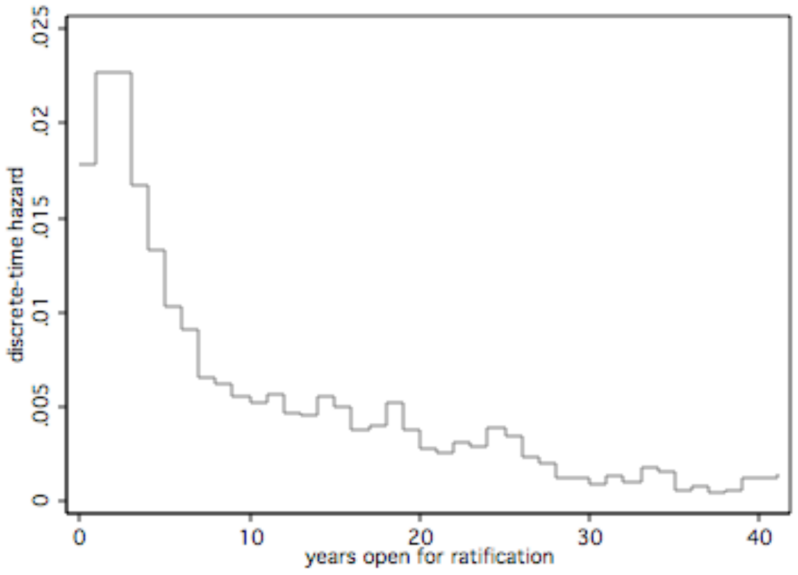

Figure 6.3: *Baseline Hazard*

Of the 255 Treaties in the main sample,

- 132 have been ratified by France
- 132 by Germany
- 126 by the UK
- 127 by Spain
- 82 by Russia
- 74 by the US
- 58 by Brazil

- 50 by China
- 49 by India

by the end of our period of analysis. The mean number of treaties a country has ratified by the end of the period of analysis is 35. The mean number of treaties ratified per country and year is 0.21.

The mean number of countries that have ratified a treaty

- after 1 year is 3
- after 2 years it is 8
- after 3 years 12
- after 4 years 15
- after 5 years 17
- by the end of the period of analysis: 30.

Regarding the emergence of new treaties within the period of analysis, 35 additional treaties emerged between 1960 and 1969, 52 in the following decade, 66 from 1980 to 1989, and 84 from 1990 to 2000.

Table 6.6: *Ratification hazards*

Years open for ratification	baseline hazard
.00	.02
1	.02
2	.02
3	.02
4	.01
5	.01
6	.01
7	.01
8	.01
9	.01
10	.01
11	.01
12	.01
13	.01
14	.01
15	.01
16	.00
17	.00
18	.01
19	.00
20	.00
21	.00
22	.00
23	.00
24	.00
25	.00
26	.00
27	.00
28	.00
29	.00
30	.00
31	.00
32	.00
33	.00
34	.00
35	.00
36	.00
37	.00
38	.00
39	.00
40	.00
41	.00
42	.00

6.5.1.1 Illustrations of Treaty Ratification Trajectories

The following figures show the ratification trajectories for eleven of the twenty-two treaties analyzed by Roberts et al. (2004). To illustrate the time dynamics of treaty ratification we have graphed the (cumulated) number of ratifications over time.

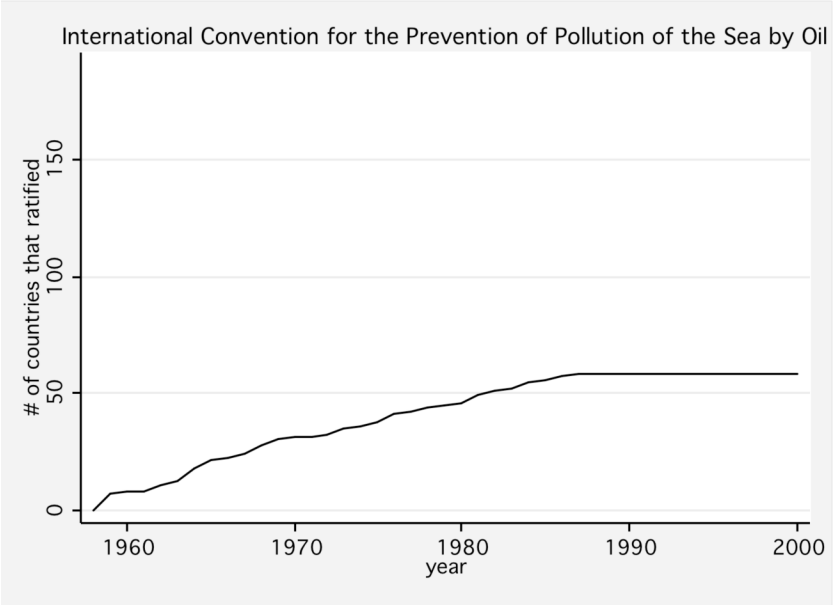

Figure 6.4: *International Convention for the Prevention of Pollution of the Sea by Oil*

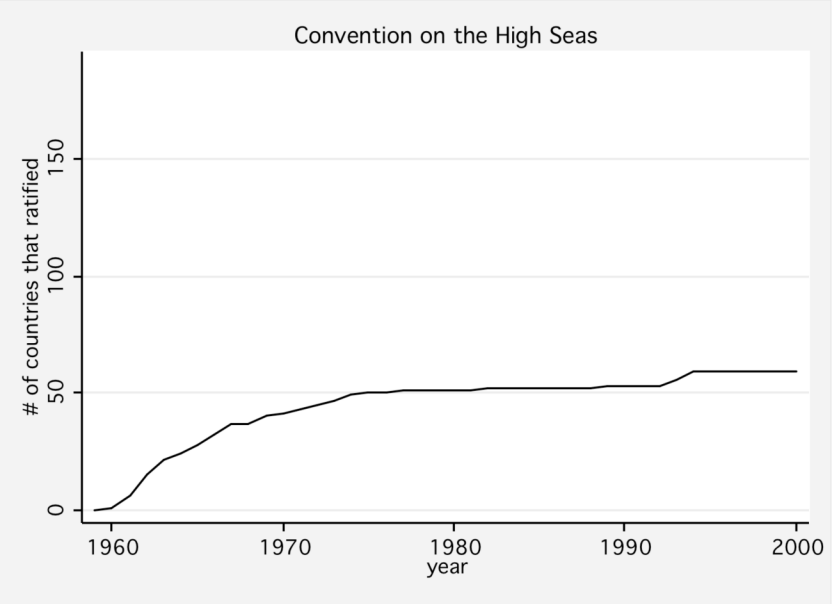

Figure 6.5: *Convention on the High Seas*

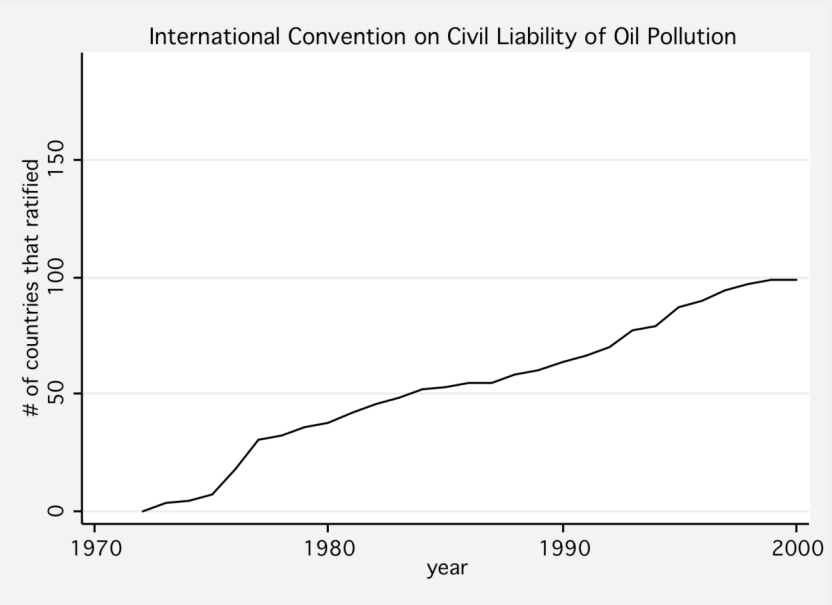

Figure 6.6: *International Convention on Civil Liability of Oil Pollution*

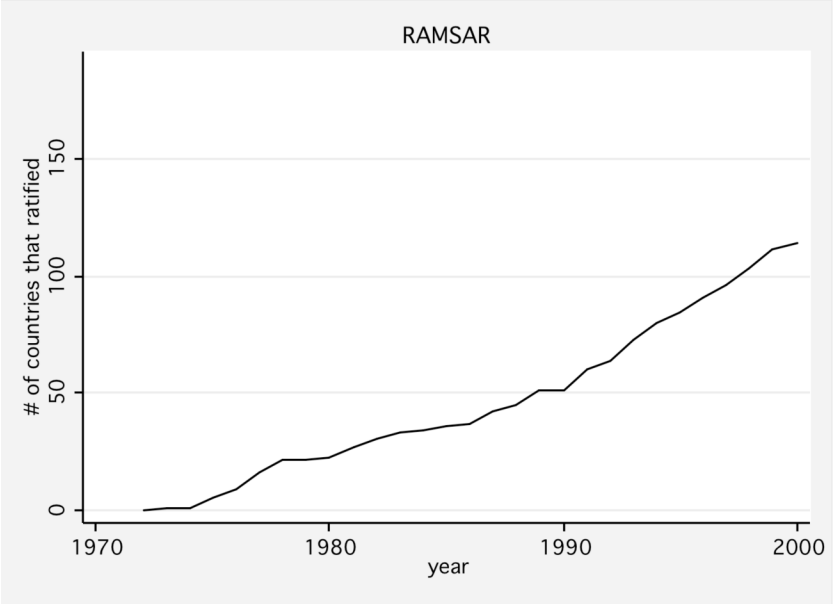

Figure 6.7: *RAMSAR*

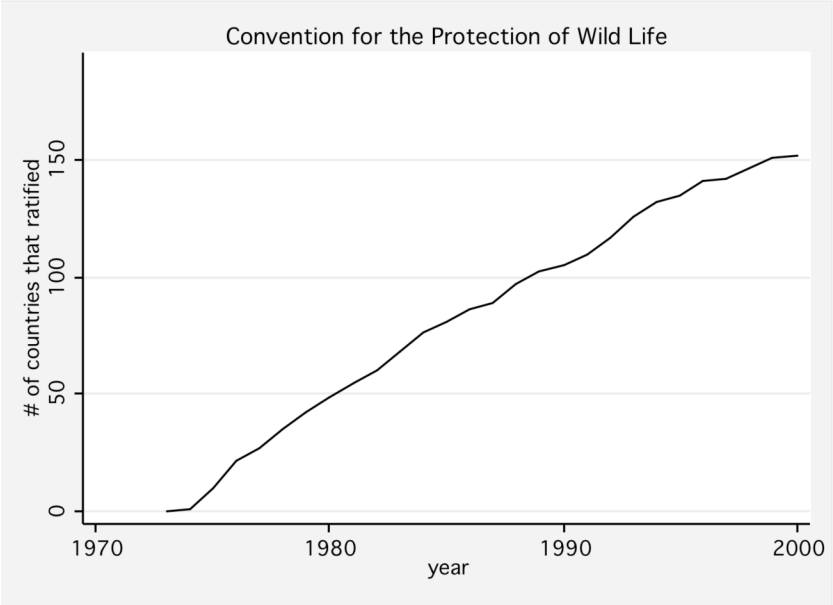

Figure 6.8: *Convention for the Protection of Wild Life*

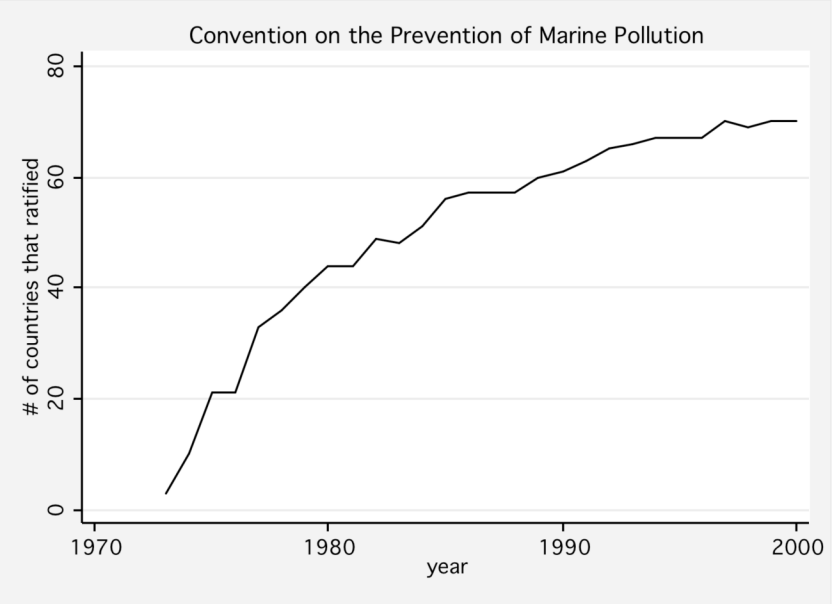

Figure 6.9: *Convention for the Prevention of Marine Pollution*

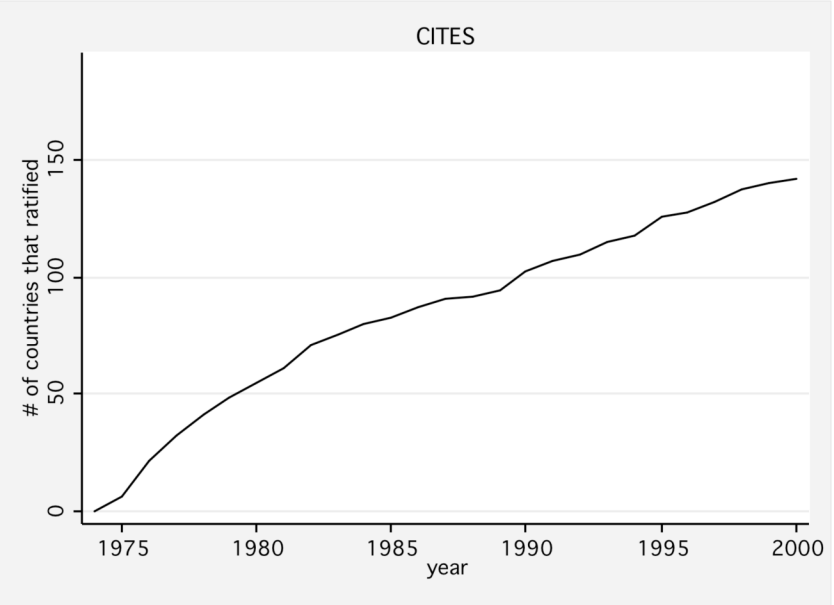

Figure 6.10: *CITES*

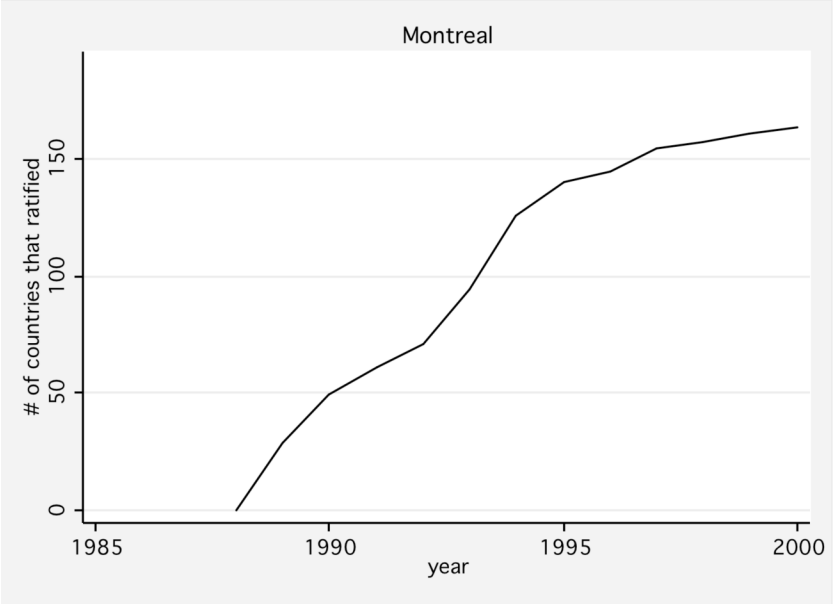

Figure 6.11: *Montreal*

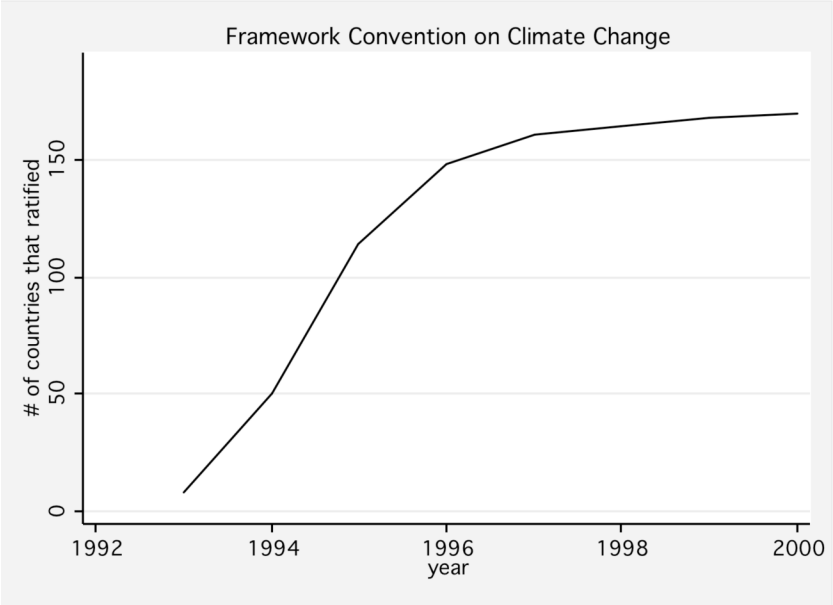

Figure 6.12: *Framework Convention on Climate Change*

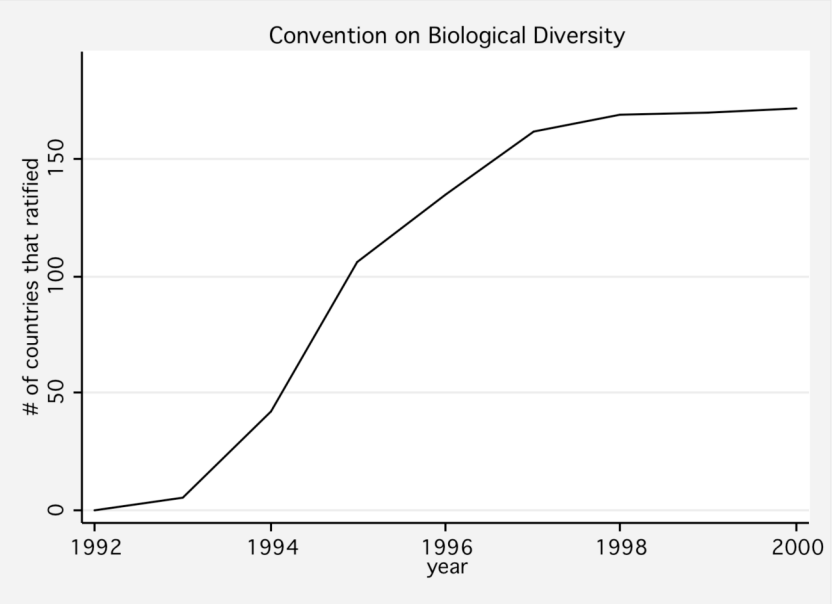

Figure 6.13: *Convention on Biological Diversity*

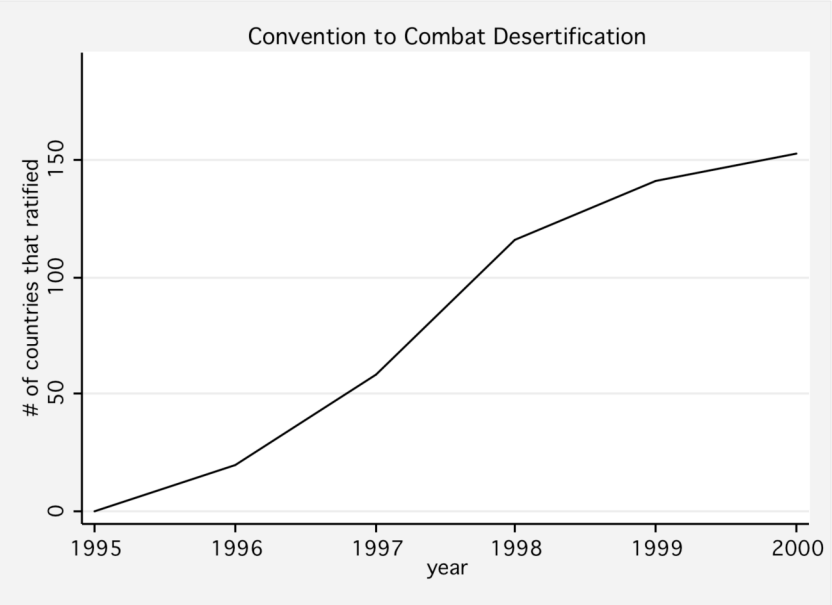

Figure 6.14: *Convention to Combat Desertification*

6.5.2 Correlation Coefficients

Table 6.7 shows the correlation coefficients for all our independent variables.

6.5.3 Robustness Checks

6.5.3.1 Alternative measures for the independent variables

The effect of IO membership is independent of whether we define the IO variable as full, associated, or observer membership. For the results shown in the main paper, the most comprehensive IO membership definition was used. The results for the more narrow definitions of the IO variable are shown in columns 2 and 3 in Table 6.8. Using these IO membership definitions does not induce any substantive change to the variables.

Table 6.7: *Correlation Coefficients*

	trade intensity	Polity	Civil liberties	Political rights	IO membership	ln GDP per capita	ln GDP per capita^2	ln SO_2 per capita	# of countries	% income	% region	age of treaty
ln trade intensity	1.00											
Polity	0.22	1.00										
Civil liberties	0.31	0.84	1.00									
Political rights	0.28	0.9	0.92	1.00								
IO membership	0.30	0.44	0.46	0.44	1.00							
ln GDP per capita	0.51	0.42	0.56	0.53	0.38	1.00						
ln GDP per capita^2	0.52	0.42	0.56	0.53	0.39	1.00	1.00					
ln SO_2 per capita	0.04	0.21	0.20	0.22	0.39	0.43	0.43	1.00				
# of countries	-0.00	-0.03	-0.06	-0.06	-0.06	-0.06	-0.07	-0.05	1.00			
% income	0.10	0.03	0.05	0.05	0.05	0.16	0.17	0.08	0.74	1.00		
% region	0.09	0.11	0.05	0.05	0.10	0.11	0.11	0.03	0.64	0.64	1.00	
age of treaty	0.07	0.04	0	0.01	0.06	-0.01	-0.01	-0.02	0.25	0.15	0.12	1.00
GDP	0.04	0.35	0.34	0.37	0.54	0.57	0.57	0.83	-0.06	0.11	0.05	0.00

Table 6.8: *Principal Model, Using Alternative Measures and Additional Indicators*

	(1) Democracy (Vanhanen)	(2) Full IO membership	(3) Full and associate IO membership	(4) Population	(5) Exports
IO membership (full, assoc., obs.)	0.01*	-	-	0.01***	0.01**
	(0.00)			(0.00)	(0.00)
IO membership (full)	-	0.01***	-	-	-
		(0.00)			
IO membership (full and associate)	-	-	0.01***	-	-
			(0.00)		
ln trade intensity	-0.11**	-0.12**	-0.13**	-0.12**	-
	(0.05)	(0.05)	(0.05)	(0.05)	
# of other coun-tries that ratified	0.02***	0.02***	0.02***	0.02***	0.02***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
% of same income group that ratified	0	0	0	0	0
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
% of countries in region that ratified	0.03***	0.03***	0.03***	0.03***	0.03***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Democracy (Polity)	-	0.01*	0.01*	0.01*	0.01*
		(0.01)	(0.01)	(0.01)	(0.01)
Democracy (Vanhanen)	0.01***	-	-	-	-
	(0.00)				
ln GDP p.c.	0.98*	0.93	0.95	0.86	0.95
	(0.56)	(0.62)	(0.62)	(0.63)	(0.62)
ln GDP p.c.^{2}	-0.05	-0.04	-0.04	-0.04	-0.04
	(0.03)	(0.04)	(0.04)	(0.04)	(0.04)
ln SO2 p.c.	0.06**	0.09***	0.09***	0.09***	0.09***
	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
ln GDP	0.01	-0.07	-0.08	-	-0.06
	(0.07)	(0.07)	(0.07)		(0.07)
Population	-	-	-	-0.07	-
				(0.07)	
Africa	-0.31**	-0.51***	-0.51***	-0.51***	-0.53***
	(0.14)	(0.15)	(0.15)	(0.15)	(0.15)
North America	-0.48***	-0.54***	-0.54***	-0.55***	-0.54***
	(0.16)	(0.17)	(0.16)	(0.16)	(0.15)
Latin America	-0.37***	-0.55***	-0.55***	-0.54***	-0.55***
	(0.11)	(0.13)	(0.13)	(0.12)	(0.13)
East Asia	-0.43***	-0.46***	-0.46***	-0.46***	-0.48***
	(0.13)	(0.14)	(0.14)	(0.14)	(0.14)
West Asia	-0.60***	-0.71***	-0.71***	-0.71***	-0.73***
	(0.15)	(0.16)	(0.16)	(0.16)	(0.16)
ln (exports/GDP)	-	-	-	-	-0.10*
					(0.05)
t	-0.33***	-0.33***	-0.33***	-0.33***	-0.33***
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
t^2	0.01***	0.01***	0.01***	0.01***	0.01***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
t^3	-0.00***	-0.00***	-0.00***	-0.00***	-0.00***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Constant	-11.09***	-9.39***	-9.46***	-9.90***	-9.27***
	(2.65)	(2.99)	(2.98)	(2.84)	(2.99)
Observations	614,679	574,196	574,196	574,196	574,196

Note: Robust standard errors in parentheses. *** p< 0.01, ** p<0.05, * p<0.1

Similarly, the results are robust to using Vanhanen's democracy index (Vanhanen 2000a) instead of the Polity IV index (column 1 in Table 6.8) and population instead of GDP (column 4, in Table 6.8). A central argument in our theory relating trade intensity to treaty ratification suggests that most environmental treaties act similar to a tax on exportables. Hence, one could argue that it would be more appropriate to proxy trade intensity with exports divided by GDP instead of both exports and imports divided by GDP. As can be seen in column 5, Table 6.8 the results are robust to using exports instead of trade intensity.

6.5.3.2 Alternative estimation methods

To assess whether our results are sensitive to the estimation method, we also estimated the models using cubic splines and time dummies, as proposed by Beck et al. (1998) to control for temporal dependence. The results, which are shown in columns 1 and 2 in Table 6.9, are very similar to those obtained when using t, t^2 and t^3. The major difference to the main specification is that ratification behaviour of the income-related peer group turns out to be positive and significant when using cubic splines (column 1, Table 6.9) whereas the positive coefficient of democracy looses its statistical significance. The results using time dummies as displayed in column 2 in Table 6.9 [25] are identical with those obtained by our baseline model except for the coefficient of democracy, which does no longer reach statistical significance. Hence these additional results suggest we can be rather confident that our main results are robust to the approach to deal with time dependence.

The particular structure of our dataset implies that the events of interest, namely ratifications of global environmental agreements, are rare events. As noted in Table 6.7 of the article, only 0.88 per cent of the observations in our dataset are coded as 1. To assess whether this influences our results we also use the rare events logit estimator proposed by Tomz et al. (1999) (see also King & Zeng 1999). Since the results do not change when controlling for rare events (column 3, Table 6.9) we decided to use the standard logit approach for the principal model.

[25] The actual results for the 52 time dummies are not shown in column 2, Table 6.9 for lack of space.

Table 6.9: *Robustness Checks of Principal Model: methods and additional controls*

	(1) Splines	(2) Time dummies	(3) Rare events logit	(4) Major power	(5) Stockholm	(6) Rio	(7) Stockholm + Rio
IO Membership	0.02***	0.01***	0.01***	0.01***	0.01***	0.01***	0.01***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
ln trade intensity	-0.14***	-0.13**	-0.12**	-0.12**	-0.11*	-0.08	-0.08
	(0.05)	(0.05)	(0.05)	(0.05)	(0.06)	(0.05)	(0.06)
# of other coun-tries that ratified	0.01***	0.02***	0.02***	0.02***	0.02***	0.02***	0.03***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
% of same income group that ratified	0.02***	0	0	0	0	0	0
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
% of countries in region that ratified	0.03***	0.03***	0.03***	0.03***	0.03***	0.03***	0.03***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Democracy (Polity)	0	0.01	0.01*	0.01*	0.01*	0.01**	0.01**
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
IO Membership	0.02***	0.01***	0.01***	0.01***	0.01***	0.01***	0.01***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
ln GDP p.c.	0.88	0.92	0.93	0.97	0.95	1.12*	1.12*
	(0.56)	(0.61)	(0.62)	(0.62)	(0.61)	(0.61)	(0.60)
ln GDP p.c.^{2}	-0.04	-0.04	-0.04	-0.04	-0.04	-0.05	-0.05
	(0.03)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)
ln SO_2 p.c.	0.09***	0.09***	0.09***	0.09***	0.09***	0.08**	0.07**
	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
ln GDP	-0.10*	-0.07	-0.07	-0.08	-0.07	-0.06	-0.06
	(0.06)	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)
Major power	-	-	-	0.07	-	-	-
				(0.13)			
After Stockholm	-	-	-	-	-0.07	-	-0.04
					(0.10)		(0.09)
After Rio	-	-	-	-	-	-0.26***	-0.26***
						(0.07)	(0.06)
Spline 1	0.02***	-	-	-	-	-	-
	(0.00)						
Spline 2	-0.02***	-	-	-	-	-	-
	(0.00)						
Spline 3	0.00***	-	-	-	-	-	-
	(0.00)						
Africa	-0.34**	-0.51***	-0.51***	-0.50***	-0.50***	-0.51***	-0.50***
	(0.15)	(0.15)	(0.15)	(0.15)	(0.15)	(0.15)	(0.15)
North America	-0.43***	-0.54***	-0.54***	-0.57***	-0.54***	-0.50***	-0.50***
	(0.16)	(0.16)	(0.16)	(0.17)	(0.16)	(0.14)	(0.14)
Latin America	-0.31***	-0.54***	-0.54***	-0.54***	-0.54***	-0.55***	-0.55***
	(0.11)	(0.12)	(0.12)	(0.13)	(0.13)	(0.13)	(0.13)
East Asia	-0.12	-0.46***	-0.46***	-0.46***	-0.46***	-0.44***	-0.44***
	(0.12)	(0.14)	(0.14)	(0.14)	(0.14)	(0.14)	(0.14)
West Asia	-0.50***	-0.71***	-0.71***	-0.71***	-0.71***	-0.66***	-0.65***
	(0.15)	(0.16)	(0.16)	(0.16)	(0.16)	(0.16)	(0.16)
t	-	-	-0.33***	-0.33***	-0.33***	-0.33***	-0.33***
			(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
t^2	-	-	0.01***	0.01***	0.01***	0.01***	0.01***
			(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
t^3	-	-	-0.00***	-0.00***	-0.00***	-0.00***	-0.00***
			(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Constant	-9.55***	-9.65***	-9.38***	-9.45***	-9.31***	-9.61***	-9.56***
	(2.58)	(2.96)	(2.97)	(2.96)	(2.98)	(2.95)	(2.96)
Observations	574,196	571,659	574,196	574,196	574,196	574,196	574,196

Note: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

6.5.4 Additional Control Variables and Estimation Procedures

We have also evaluated whether the inclusion of further control variables changes the results. In column 5 in Table 6.9 we include a dummy variable that indicates the period after the 1972 UN Conference on the Human Environment that took place in Stockholm. This conference is a widely acknowledged milestone in the field of global environmental co-operation, whereupon the importance of environmental issues at the international level should have increased. However, in contrast to our expectations, the likelihood of treaty ratification is smaller in the post-Stockholm period although the coefficient is not statistically significant. If we also include a dummy variable characterizing the period after the UN Conference on Environment and Development in Rio de Janeiro in 1992, another milestone in global environmental cooperation (column 6, Table 6.9), we again see that the coefficient is negative and this time it reaches statistical significance. When both dummies are included in the statistical model, as shown in column 7 in Table 6.9, both effects are negative but only the coefficient for the Rio conference is statistically significant. This seems to suggest that the likelihood for treaty ratification is lower in the period after the UN Conference on Environment and Development.

Our principal dataset includes all multilateral environmental treaties that were identified as such by CIESIN (2006), Mitchell (2008*a*). Hence our definition of what is to be considered a multilateral environmental treaty follows from the coding decisions of these two sources. We then decided to exclude treaties that, although having an environmental component, were designed for entirely different purposes. One example is the "Constitution of the UN Educational Scientific and Cultural Organization". That is, the dataset on which the principal models are based includes the merged (and restructured) data from the two sources mentioned, but was purged from agreements of marginal environmental relevance before we ran the regressions. The dataset for the principal models thus includes 255 of the around 450 multilateral environmental agreements in the original dataset. Table 6.12 shows all treaties included in the principal dataset.

All of the 255 agreements are de jure open to all countries on Earth. But de facto there are still some agreements in our dataset that appear more relevant to particular countries or regions. We have sought to control for such effects by using region dummies that capture geographic or climatic characteristics that may make a treaty particularly relevant for the countries in the given region. Because the sample boundaries are obviously not very firm, we have carried out two additional robustness checks that focus on sample composition. First, we have implemented the models for a sub-sample that includes only those treaties that have no obvious regional focus. This sub-sample contains 113 instead of 255 treaties and excludes treaties such as for example the "Cooperation Agreement for the Protection of the Coasts and Waters of the North-East Atlantic against Pollution". The treaties included in this reduced sample are listed in Table 8. Table 6.10, column 1 shows that the results do not differ much from those obtained for the principal models. Second, we reduced the original sample to the 22 treaties that Roberts et al. (2004) included in their analysis (shown in Table 9). Except for trade intensity and two of the control variables – stringency of domestic environmental quality and GDP per capita – which become insignificant, all of our main results survive (column 2, Table 6.10).

Since all treaty-country pairs in which the given country has not yet ratified the treaty by the year 2000 (the year our dataset ends) are included in the dataset, our data is right-censored. Although Beck et al. (1998, 1272) note that right-censored data '[...] are not a problem for

Table 6.10: *Robustness Checks of Principal Model*

	(1) Excluding regional treaties	(2) Roberts	(3) Truncation	(4) Excluding small traders	(5) Excluding big traders
IO membership	0.01***	0.03***	0.01**	0.01**	0.01**
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
ln trade intensity	-0.09*	-0.06	-0.14**	-0.17***	-0.12**
	(0.06)	(0.07)	(0.05)	(0.06)	(0.06)
# of other coun-tries that ratified	0.02***	0.02***	0.02***	0.02***	0.02***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
% of same income group that ratified	0	-0.01	0	0	0
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
% of countries in region that ratified	0.02***	0.02***	0.03***	0.03***	0.03***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Democracy (Polity)	0.02***	0.02**	0.01*	0.01*	0.01
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
ln GDP p.c.	0.64	1.08	0.89	0.8	0.66
	(0.63)	(0.75)	(0.63)	(0.63)	(0.64)
ln GDP p.c. ^{2}	-0.02	-0.07	-0.04	-0.03	-0.02
	(0.04)	(0.05)	(0.04)	(0.04)	(0.04)
ln SO_2 p.c.	0.08**	0.03	0.11***	0.10***	0.11***
	(0.03)	(0.05)	(0.04)	(0.03)	(0.04)
ln GDP	-0.04	-0.07	-0.07	-0.07	-0.08
	(0.07)	(0.08)	(0.07)	(0.07)	(0.07)
Africa	-0.46***	-0.38**	-0.53***	-0.53***	-0.53***
	(0.16)	(0.17)	(0.15)	(0.15)	(0.15)
North America	-0.74***	-0.45*	-0.56***	-0.58***	-0.58***
	(0.24)	(0.26)	(0.12)	(0.16)	(0.15)
Latin America	-0.47***	-0.36**	-0.54***	-0.58***	-0.54***
	(0.13)	(0.16)	(0.13)	(0.13)	(0.13)
East Asia	-0.32**	-0.05	-0.49***	-0.51***	-0.49***
	(0.14)	(0.18)	(0.15)	(0.15)	(0.15)
West Asia	-0.55***	-0.22	-0.82***	-0.80***	-0.77***
	(0.16)	(0.19)	(0.15)	(0.16)	(0.16)
t	-0.27***	-0.22***	-0.32***	-0.31***	-0.31***
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
t^2	0.01***	0.01***	0.01***	0.01***	0.01***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
t^3	-0.00***	-0.00*	-0.00***	-0.00***	-0.00***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Constant	-8.17***	-7.74**	-9.62***	-9.67***	-8.27***
	(2.92)	(3.68)	(3.09)	(3.06)	(3.14)
Observations	240,993	45,599	721,904	718,953	716,151

Note: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

grouped duration logit analysis' we implemented our principal models for a sub-sample that excludes all treaties that entered the original dataset after 1994. The idea is that all countries in the sub-sample have had at least six years to ratify a particular treaty[26]; this should reduce the potential problem of right-censoring very much. The results, which are shown (column 3, Table 6.10), are almost identical to the results presented for the principal models.

We revisited the results for the trade variable to examine whether they might be disproportionately influenced by those countries that trade heavily or only very little. Column 4 in Table 6.10 reports results for a sub-sample that excludes those 5 per cent of the countries in our full sample that trade the least, whereas the results reported in column 5 are based on a sub-sample that excludes those 5 per cent that trade the most. The results from our principal models survive very well. The only exception is democracy, which turns statistically insignificant in the model excluding those 5 per cent that trade the most.

As mentioned at the beginning of the section on the statistical method, combining all multilateral environmental treaties into one dataset necessarily introduces some unit heterogeneity. To control for this heterogeneity between the different treaties and thus to show the robustness of our results we have taken several steps. First, by including regional dummies we control for the fact that countries that are situated in a common region with specific geographic and climate characteristics might be more likely to ratify the same specific set of treaties. Thus, for example, countries from the Middle East may be more willing to participate in treaties dealing with desertification. Second, by reducing our dataset to a subset including only 22 of the most important multilateral environmental treaties, as proposed by Roberts et al. (2004), we can demonstrate that our results hold even if we consider only very specific and very similar treaties. Finally, we estimated our baseline model using a conditional logit model with treaty fixed-effects. The results in column 1, Table 6.11 show that with the exception of one variable all of our main results persist. Only the number of countries in a particular country's income group that have already ratified this treaty is now negative and statistically significant. Consequently, one can infer from these results that our most important results hold true even if we control for the unit heterogeneity introduced by combining different environmental treaties in one dataset. It would of course be desirable to include variables measuring the degree of institutionalization and legalization of a specific treaty in order to model treaty heterogeneity directly. However, this would be connected with a huge data collection effort and is therefore intended to be our next major research project.

In addition to the aforementioned robustness checks we have evaluated the results of our analysis using a complementary log-log model, which is the equivalent to a proportional hazards model when 'the survival times are interval censored' (Rabe-Hesketh & Skrondal 2008, 354). As can be seen in column 2 in Table 6.11 the results are robust to this change of econometric approach.

[26] The decision to leave out all treaties that were been created during the last six years of our dataset is somewhat arbitrary. However, the results do not change if we leave out the treaties for the last five or seven years. The importance of this robustness check is simply to show that right-censoring is not a problem in our analysis.

Table 6.11: *Robustness Checks of Principal Model*

	(1) Conditional Logit	(2) Complementary Log-Log exp(b)
IO membership	0.02***	1.01***
	(0.00)	(0.00)
ln trade intensity	-0.05**	0.88**
	(0.02)	(0.05)
# of other countries that ratified	0.01***	1.02***
	(0.00)	(0.00)
% of same income group that ratified	-0.01***	1.00
	(0.00)	(0.00)
% of countries in region that ratified	0.03***	1.03***
	(0.00)	(0.00)
Democracy (Polity)	0.01***	1.01*
	(0.00)	(0.01)
ln GDP p.c.	0.97***	2.22
	(0.25)	(0.61)
ln GDP p.c.^{2}	-0.04***	0.97
	(0.02)	(0.04)
ln SO_2 p.c.	0.06***	1.09***
	(0.01)	(0.03)
ln GDP	-0.04*	-0.93
	(0.02)	(0.07)
Africa	-0.50***	0.62***
	(0.05)	(0.14)
North America	-0.49***	0.58***
	(0.10)	(0.17)
Latin America	-0.57***	0.60***
	(0.05)	(0.12)
East Asia	-0.42***	0.65***
	(0.06)	(0.14)
West Asia	-0.60***	0.52***
	(0.06)	(0.15)
t	-0.11***	
	(0.00)	
Observations	555,766	571,659

Note: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

6.5.5 Illustration of Effect Sizes

Figures 6.15 to 6.21 illustrate the effect sizes of the independent variables on the likelihood of treaty ratification.

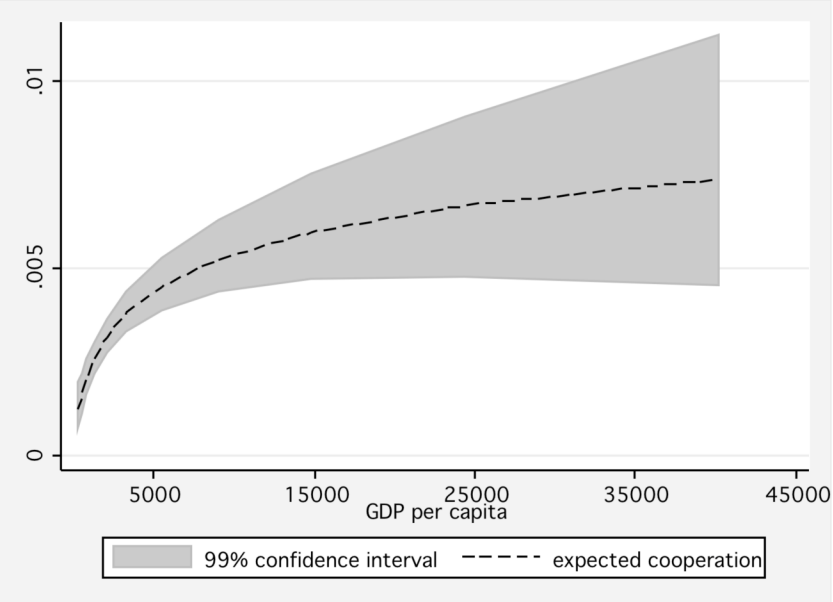

Figure 6.15: *Effect of GDP p.c. on the likelihood of treaty ratification*

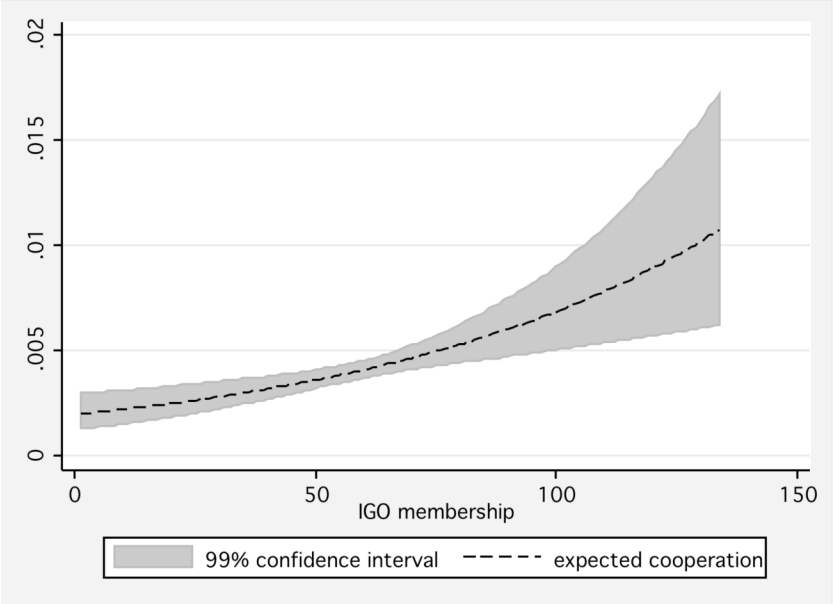

Figure 6.16: *Effect of IO membership on the likelihood of treaty ratification*

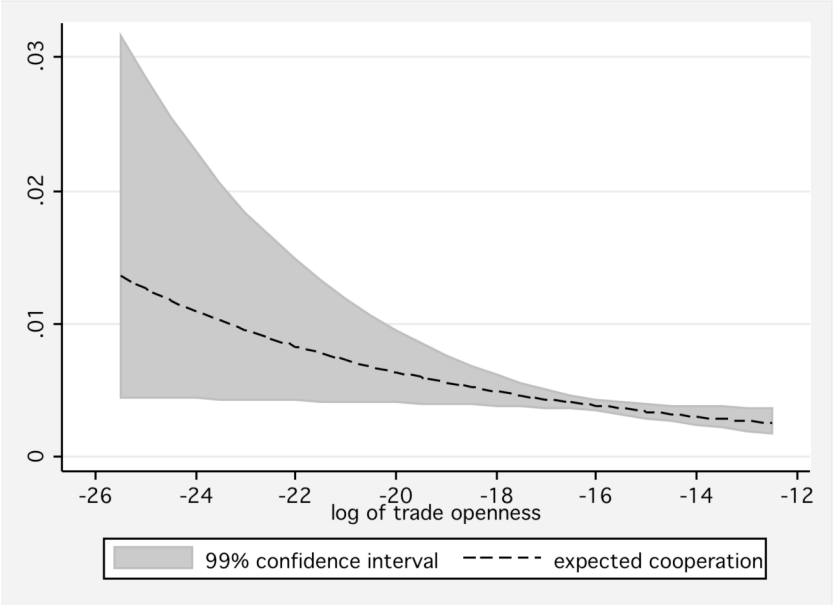

Figure 6.17: *Effect of log of trade intensity on the likelihood of treaty ratification*

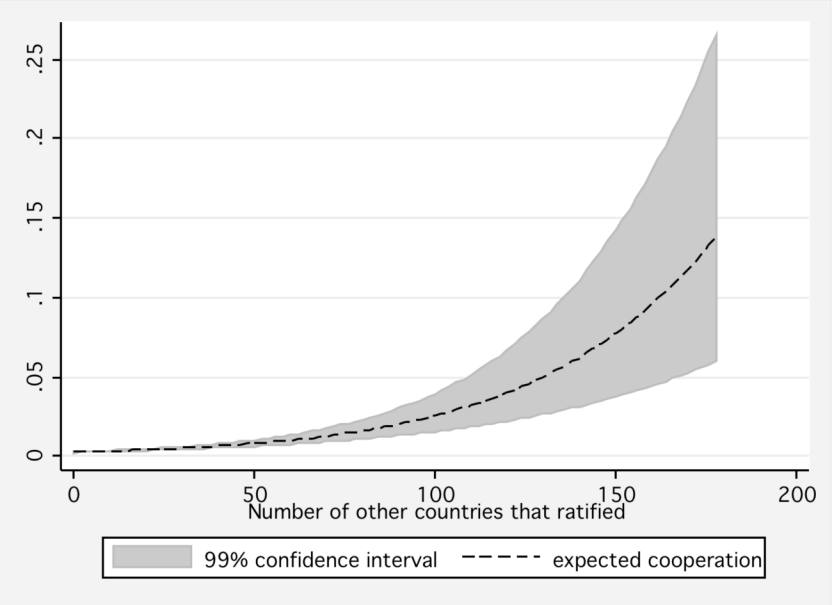

Figure 6.18: *Effect of number of other countries that have ratified on the likelihood of treaty ratification*

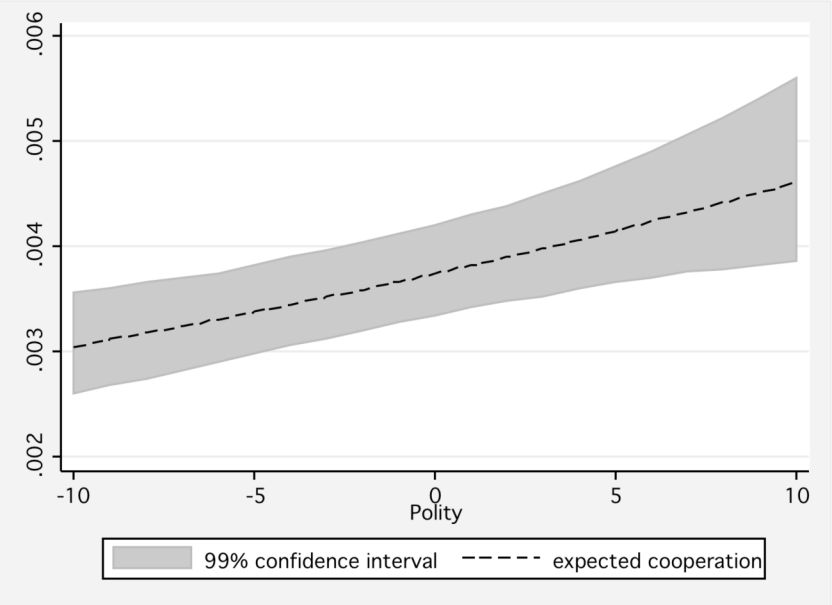

Figure 6.19: *Effect of democracy on the likelihood of treaty ratification*

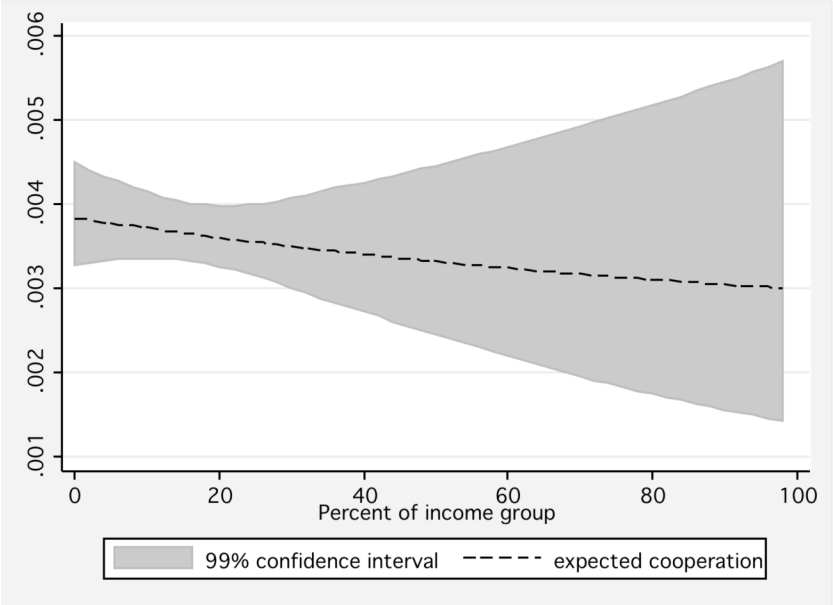

Figure 6.20: *Effect of percent of countries in the same income group on the likelihood of treaty ratification*

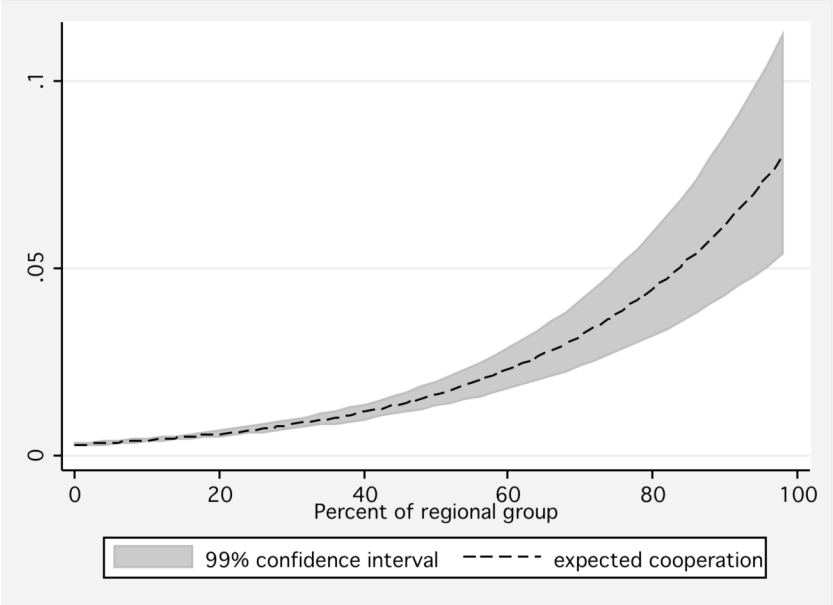

Figure 6.21: *Effect of percent of countries in the same region on the likelihood of treaty ratification*

Table 6.12: List of all treaties included in the principal dataset

Treatyname
Protocol Of Amendment To The Convention On The Inter-American Institute Of Agricultural Sciences
Agreement Concerning Cooperation In The Quarantine Of Plants And Their Protection Against Pests And Diseases
Convention On The African Migratory Locust Organization
Amendments To The Agreement For The Establishment Of A General Fisheries Commission For The Mediterranean
Additional Protocol I To The Treaty For The Prohibition Of Nuclear Weapons In Latin America
Additional Protocol II To The Treaty For The Prohibition Of Nuclear Weapons In Latin America
Convention On The Conservation Of The Living Resources Of The Southeast Atlantic
International Convention On Civil Liability For Oil Pollution Damage
International Convention On The Establishment Of An International Fund For Compensation For Oil Pollution Damage
Convention For The Prevention Of Marine Pollution By Dumping From Ships And Aircraft
Convention On The Prevention Of Marine Pollution From Land-Based Sources
Protocol To The International Convention On Civil Liability For Oil Pollution Damage
Agreement On Regional Cooperation In Combating Pollution Of The Southeast Pacific By Oil And Other Harmful Substances In Cases Of Emergency
Western Indian Ocean Tuna Organization Convention
Protocol Of Amendment To The European Convention For The Protection Of Animals Kept For Farming Purposes
Agreement Establishing The Inter-American Institute For Global Change Research
Protocol For The Implementation Of The Alpine Convention Concerning Town And Country Planning And Sustainable Development
Protocol For The Implementation Of The Alpine Convention Concerning Nature Protection And Landscape Conservation
Protocol For The Implementation Of The Alpine Convention Concerning Mountain Agriculture
Protocol For The Implementation Of The Alpine Convention Concerning Mountain Forests
Protocol To The United Nations Framework Convention On Climate Change
Protocol Of Amendment To The European Convention For The Protection Of Vertebrate Animals Used For Experimental And Other Scientific Purposes
Protocol On Heavy Metals To The Convention On Long-Range Transboundary Air Pollution
Protocol On Persistent Organic Pollutants To The Convention On Long-Range Transboundary Air Pollution
Convention On The Prior Informed Consent Procedure For Certain Hazardous Chemicals And Pesticides In International Trade
Protocol For The Implementation Of The Alpine Convention Concerning Tourism
Protocol For The Implementation Of The Alpine Convention Concerning The Protection Of Soils
Protocol For The Implementation Of The Alpine Convention Concerning Energy
19990611 Protocol To Amend The Convention For The Establishment Of An Inter-American Tropical Tuna Commission

Protocol Concerning Pollution From Land-Based Sources And Activities
Agreement For The Establishment Of The Regional Commission For Fisheries
Protocol To Abate Acidification, Eutrophication And Ground-Level Ozone To The Convention On Long-Range Transboundary Air Pollution
Protocol On Liability And Compensation For Damage Resulting From Transboundary Movements Of Hazardous Wastes And Their Disposal
Cartagena Protocol On Biosafety To The Convention On Biological Diversity
Convention on the Conservation and Management of the Highly Migratory Fish Stocks of the Western and Central Pacific Ocean
European Landscape Convention
Protocol For The Implementation Of The Alpine Convention Concerning Transportation
Protocol For The Implementation Of The Alpine Convention Concerning Dispute Settlement
Agreement For The Establishment Of A Commission For Controlling The Desert Locust In The Western Region
Convention On Persistent Organic Pollutants
Agreement On The Conservation Of Albatrosses And Petrels
International Treaty On Plant Genetic Resources For Food And Agriculture
ASEAN Agreement On Transboundary Haze Pollution
Convention for the Conservation of Antarctic Seals
International Convention for the Protection of Birds
International Convention for the Regulation of Whaling
Convention concerning Fishing in the Black Sea
Agreement on the Protection of the Salmon in the Baltic Sea
Agreed Measures for the Conservation of Antarctic Fauna and Flora
Convention for the Establishment of an Inter-American Tropical Tuna Commission
International Convention for the Conservation of Atlantic Tunas
Protocol Concerning Regional Co-operation in Combating Pollution by Oil and other Harmful Substances in Cases of Emergency
Protocol relating to the International Convention for the Safety of Life at Sea (SOLAS Prot.)
International Convention relating to Intervention on the High Seas in Cases of Oil Pollution Casualties
International Convention for the Prevention of Pollution from Ships (MARPOL)
International Convention for the Safety of Life at Sea (SOLAS)
Protocol relating to Intervention on the High Seas in Cases of Pollution by Substances other than Oil
Convention Relating to Civil Liability in the Field of Maritime Carriage of Nuclear Material
Agreement for the Establishment of a Commission for Controlling the Desert Locust in the Near East
Agreement for the Establishment of a Commission for Controlling the Desert Locust in the Eastern Region of its Distribution Area in South-West Asia
Agreement for the Establishment of a Commission for Controlling the Desert Locust in North-West Africa
Constitution of the European Commission for the Control of Foot -and- Mouth Disease
Agreement for the Establishment of a General Fisheries Commission for the Mediterranean
International Plant Protection Convention
Convention on the Conservation of Antarctic Marine Living Resources

International Convention for the Prevention of Pollution of the Sea by Oil 1962 and 1969
Plant Protection Agreement for the Asia and Pacific Region
Convention on the Prohibition of Military or any other Hostile Use of Environmental Modification Techniques
Convention on Fishing and Conservation of the Living Resources of the High Seas
Convention on the High Seas
Optional Protocol of Signature concerning the Compulsory Settlement of Disputes [Arising Out Of The United Nations Conference On The Law Of The Sea]
Convention on the Continental Shelf
European Agreement concerning the International Carriage of Dangerous Goods by Road (ADR)
Convention on the Protection of the Marine Environment of the Baltic Sea Area
Optional Protocol concerning the Compulsory Settlement of Disputes
Convention on Civil Liability for Nuclear Damage
Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space Moon and other Celestial Bodies
Treaty on the Non-Proliferation of Nuclear Weapons
Treaty on the Prohibition of the Emplacement of Nuclear Weapons and other Weapons of Mass Destruction on the Sea-Bed and the Ocean Floor and in the
Treaty Banning Nuclear Weapon Tests in the Atmosphere Outer Space and under Water
Convention on the Prohibition of the Development Production and Stockpiling of Bacteriological (Biological) and Toxin Weapons and on their Destru
Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter
North-East Atlantic Fisheries Convention
Fisheries Convention
Convention on Third Party Liability in the Field of Nuclear Energy
Convention on the Establishment of a Security Control in the Field of Nuclear Energy
Convention concerning the Protection of Workers against Occupational Hazards in the Working Environment due to Air Pollution
Convention concerning Protection against Hazards of Poisoning arising from Benzene (ILO No.136)
Convention concerning the Protection of Workers against Ionising Radiations (ILO No. 115)
European Agreement on the Restriction of the Use of certain Detergents in Washing and Cleaning Products
European Convention on the Protection of the Archaeological Heritage
The Antarctic Treaty
European Convention for the Protection of Animals during International Transport
Additional Protocol to the European Convention for the Protection of Animals during International Transport
Convention on the Conservation of European Wildlife and Natural Habitats
Agreement concerning Measures for the Protection of the Stocks of Deep Sea Prawns (Pandalus Borealis) Lobsters (Homarus Vulgaris) (Nephrops Norvegi
Convention on International Trade in Endangered Species of Wild Fauna and Flora
African Convention on the Conservation of Nature and Natural Resources
Convention for the Establishment of the European and Mediterranean Plant Protection Organisation

Convention on the Conservation of Migratory Species of Wild Animals
Convention for the International Council for the Exploration of the Sea
Revised Convention for the Establishment of a European Organisation for Nuclear Research
Convention on Long-Range Transboundary Air Pollution
Convention concerning the Protection of the World Cultural and Natural Heritage
Convention on Wetlands of International Importance especially as Waterfowl Habitat
Convention on Fishing and Conservation of the Living Resources in the Baltic Sea and the Belts
Convention on Future Multilateral Cooperation in the Northwest Atlantic Fisheries (NAFO)
Kuwait Regional Convention for Co-operation on the Protection of the Marine Environment from Pollution
Protocol concerning Co-operation in Combating Pollution of the Mediterranean Sea by Oil and other Harmful Substances in Cases of Emergency
Protocol for the Prevention of Pollution of the Mediterranean Sea by Dumping from Ships and Aircraft
Convention for the Protection of the Mediterranean Sea against Pollution
Protocol for the Protection of the Mediterranean Sea against Pollution from Land-Based Sources
Convention for Co-operation in the Protection and Development of the Marine and Coastal Environment of the West and Central African Region
Protocol concerning Co-operation in combating Pollution in cases of Emergency
Treaty for the Prohibition of Nuclear Weapons in Latin America
Agreement on an International Energy Program
Convention Supplementary to the Paris Convention of 29th July 1960 on Third Party Liability in the Field of Nuclear Energy as amended in 1964 and 1
Convention on the Liability of Operators of Nuclear Ships
International Convention relating to the Limitation of the Liability of Owners of Sea-going Ships
International Convention on Standards of Training Certification and Watchkeeping for Seafarers
Convention for the Conservation of Salmon in the North Atlantic Ocean
South Pacific Forum Fisheries Agency Convention
Convention for the Protection of the Marine Environment and Coastal Area of the South-East Pacific
Agreement on Regional Co-operation in Combating Pollution of the South-East Pacific by Hydrocarbons or other Harmful Substances in cases of Emergen
Regional Convention for the Conservation of the Red Sea and of the Gulf of Aden Environment
Protocol concerning Mediterranean Specially Protected Areas
United Nations Convention on the Law of the Sea
Amendments to the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter concerning Settlement of Disputes
Protocol to amend the Convention on Wetlands of International Importance especially as Waterfowl Habitat
Protocol amending the European Agreement on the Restriction of the Use of certain Detergents in Washing and Cleaning Products
Convention for the Protection and Development of the Marine Environment of the Wider Caribbean Region
Protocol concerning Co-operation in Combating Oil Spills in the Wider Caribbean Region
Protocol for the Protection of South-East Pacific against Pollution from Land-Based Sources

Supplementary Protocol to the Agreement on Regional Co-operation in Combating Pollution of the South-East Pacific by Hydrocarbons or other Harmful
International Tropical Timber Agreement
Agreement for Cooperation in Dealing with Pollution of the North Sea by Oil and other Harmful Substances
Phyto - sanitary Convention for Africa
Agreement governing the Activities of States on the Moon and other Celestial Bodies
Protocol amending the Convention for the Prevention of Marine Pollution by Dumping from Ships and Aircraft
ASEAN Agreement on the Conservation of Nature and Natural Resources
Protocol concerning Protected Areas and Wild Fauna and Flora in the Eastern African Region
Convention for the Protection of the Marine and Coastal Environment of the Eastern African Region
Protocol concerning Co-operation in Combating Marine Pollution in cases of Emergency in the Eastern African Region
Protocol to the Convention on Long-range Transboundary Air Pollution on Long-Term Financing of Co-operative Programme for Monitoring and Evaluation
Convention for the Protection of the Ozone Layer
Eastern Pacific Ocean Tuna Fishing Agreement
Protocol to the 1979 Convention on Long-range Transboundary Air Pollution on the Reduction of Sulphur Emissions or their Transboundary Fluxes by at
Convention on Conditions for Registration of Ships
Protocol Relating to Modification of the International Convention for the Conservation of Atlantic Tunas
Convention on Early Notification of a Nuclear Accident
Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency
Protocol amending the Convention for the prevention of marine pollution from land-based sources
Convention establishing a Permanent Inter-State Drought Control Committee for the Sahel
Convention for the Protection of the Natural Resources and Environment of the South Pacific Region (SPREP Convention)
Protocol for the Prevention of Pollution of the South Pacific Region by Dumping
Protocol concerning Co-operation in Combating Pollution Emergencies in the South Pacific Region
Protocol on Substances that Deplete the Ozone Layer
South Pacific Fisheries Treaty
International Convention for the Prevention of Pollution from Ships Hazardous substances carried in packaged form
International Convention for the Prevention of Pollution from Ships (MARPOL) - Annex IV (Optional): Sewage
International Convention for the Prevention of Pollution from Ships (MARPOL) - Annex V (Optional) = Garbage
Protocol Additional to the Geneva Conventions of 12 August 1949 and relating to the Protection of Victims of International Armed Conflicts (Protoco
Protocol Additional to the Geneva Conventions relating to the Protection of Victims of Non-International Armed Conflicts (Protocol II)

Protocol to the Convention on Long-Range Transboundary Air Pollution concerning the Control of Emissions of Nitrogen Oxides or their Transboundary
Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal
Protocol relating to the International Convention for the Safety of Life at Sea (SOLAS PROT 1988)
Joint Protocol relating to the application of the Vienna Convention and the Paris Convention
Agreement on transboundary cooperation with a view to preventing or limiting harmfull effects for human beings property or the environment in the e
International Convention on Salvage
Protocol Concerning Specially Protected Areas and Wildlife to the Convention for the Protection and Development of the Marine Environment of the Wi
European Convention for the Protection of Pet Animals
European Convention for the Protection of Vertebrate Animals used for Experimental and other Scientific Purposes
Convention for the Prohibition of Fishing with Long Driftnets in the South Pacific
Protocol for the Protection of the South-East Pacific against Radioactive Pollution
Protocol for the Conservation and Management of Protected Marine and Coastal Areas of the South-East Pacific
Protocol amending the Convention for the Prevention of Marine Pollution by Dumping from Ships and Aircraft
Cooperation Agreement for the Protection of the coasts and waters of the North-East Atlantic against Pollution
Amendment to the Convention on International Trade in Endangered Species of Wild Fauna and Flora (Art.XXI)
Amendments to Articles 6 and 7 of the Convention on Wetlands of International Importance especially as Waterfowl Habitat
Agreement on the Conservation of Seals in the Wadden Sea
Amendment to the Montreal Protocol on Substances that Deplete the Ozone Layer
Convention establishing a marine scientific organization for the North Pacific Region (PICES)
Convention on the Ban of the Import of Hazardous Wastes into Africa and on the Control of their Transboundary Movements within Africa
Convention on Environmental Impact Assessment in a Transboundary Context
International Convention on Oil Pollution Preparedness Response and Co-operation
Agreement for the Establishment of the Network of Aquaculture Centres in Asia and the Pacific
Protocol to the Antarctic Treaty on Environmental Protection
International Plant Protection Convention (1979 Revised Text)
Agreement on the Organisation for Indian Ocean Marine Affairs (IOMAC)
Convention concerning the Protection of Alps
Convention on fisheries cooperation among African States bordering the Atlantic Ocean
Protocol concerning Marine Pollution resulting from Exploration and Exploitation of the Continental Shelf
Protocol to the 1979 Convention on Long-Range Transboundary Air Pollution concerning the Control of Emissions of Volatile Organic Compounds or thei
Protocol I to the Convention for the the Prohibition of Fishing with Long Driftnets in the South Pacific

Protocol II to the Convention for the the Prohibition of Fishing with Long Driftnets in the South Pacific
Agreement on the Conservation of Small Cetaceans of the Baltic and North Seas
Convention on the Protection and Use of Transboundary Watercourses and International Lakes
Convention on Transboundary Effects of Industrial Accidents
United Nations Framework Convention on Climate Change
Convention on Biological Diversity
Convention on the Protection of the Black Sea against Pollution
Convention for the Protection of the Marine Environment of the North-East Atlantic
Convention on the Protection of the Marine Environment of the Baltic Sea Area
Agreement on the Conservation of Bats in Europe
Convention on the Prohibition of the Development Production and their Destruction
Convention for the Conservation of Anadromous Stocks
Amendment to the Montreal Protocol on Substances that Deplete the Ozone Layer
Regional Agreement on the transboundary movement of hazardous wastes
Agreement establishing the South Pacific Regional Environment Programme
Convention concerning Safety in the Use of Asbestos
North American Agreement on Environmental Cooperation
Protocol to amend the International Convention on the Establishment of an International Fund for Compensation for Oil Pollution Damage
Protocol to amend the International Convention on Civil Liability for Oil Pollution Damage
Agreement to Promote Compliance with International Conservation and Management Measures by Fishing Vessels on the High Seas
Protocol to the Convention on Long-Range Transboundary Air Pollution on further Reduction of Sulphur Emissions
Agreement relating to the Implementation of Part XI of the United Nations Convention on the Law of the Sea of 10 December 1982
Agreement on Co-operative Enforcement Operations directed at Illegal Trade in Wild Fauna and Flora
International Convention to Combat Desertification in those Countries Experiencing Serious Drought and or Desertification
Convention on Nuclear Safety
Protocol for the protection of the Mediterranean Sea against pollution resulting from exploration and exploitation of the continental shelf and the
Energy Charter Treaty
Protocol Concerning Specially Protected Areas and Biological Diversity in the Mediterranean
Agreement on the Conservation of African-Eurasian Migratory Waterbirds
Energy Charter Protocol on Energy Efficiency and related Environmental Aspects
Agreement for the Establishment of the Indian Ocean Tuna Commission
Agreement for the Establishment of the Near East Plant Protection Organization
Protocol to amend Paragraph 2 of Article X of the International Convention for the Conservation of Atlantic Tunas
Agreement for the Implementation of the Provisions of the United Nations Convention on the Law of the Sea relating to the Conservation and Manageme
Convention to ban the Importation into Forum Island Countries of Hazardous Wastes and Radioactive Wastes and to control the Transboundary Movement

Agreement on the Conservation of Cetaceans of the Black Sea
Treaty on the Southeast Asia Nuclear Weapon - Free Zone
Convention on the Law of the Non-Navigational Uses of International Watercourses
Inter-American Convention for the Protection and Conservation of Sea Turtles
Convention for the Conservation of Southern Bluefin Tuna
Protocol to the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter
Protocol to amend the Vienna Convention on Civil Liability for Nuclear Damage
Convention on Supplementary Compensation for Nuclear Damage
Convention on the Prohibition of the Use Production and Transfer of Anti-Personnel Mines and on their Destruction
Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management
The African Nuclear-Weapon-Free Zone Treaty
Convention on Access to Information Public Participation in Decision-Making and Access to Justice in Environmental Matters
Comprehensive Nuclear Test - Ban Treaty
Statutes of the International Centre for Genetic Engineering and Biotechnology
International Plant Protection Convention (1997 Revised Text)
Amendments to the Convention for the Protection of the Mediterranean Sea against Pollution
Amendment to the Montreal Protocol on Substances that Deplete the Ozone Layer

Table 6.13: List of reduced sample

Treatyname
Agreement Concerning Cooperation In The Quarantine Of Plants And Their Protection Against Pests And Diseases
International Convention On Civil Liability For Oil Pollution Damage
International Convention On The Establishment Of An International Fund For Compensation For Oil Pollution Damage
Convention For The Prevention Of Marine Pollution By Dumping From Ships And Aircraft
Convention On The Prevention Of Marine Pollution From Land-Based Sources
Protocol To The International Convention On Civil Liability For Oil Pollution Damage
Amendment To The Convention On The Control Of Transboundary Movements Of Hazardous Wastes And Their Disposal
Protocol To The United Nations Framework Convention On Climate Change
Convention On The Prior Informed Consent Procedure For Certain Hazardous Chemicals And Pesticides In International Trade
Protocol On Liability And Compensation For Damage Resulting From Transboundary Movements Of Hazardous Wastes And Their Disposal
Cartagena Protocol On Biosafety To The Convention On Biological Diversity
Convention On Persistent Organic Pollutants
International Treaty On Plant Genetic Resources For Food And Agriculture
International Convention for the Protection of Birds
Protocol Concerning Regional Co-operation in Combating Pollution by Oil and other Harmful Substances in Cases of Emergency
Protocol relating to the International Convention for the Safety of Life at Sea (SOLAS Prot.)
International Convention relating to Intervention on the High Seas in Cases of Oil Pollution Casualties
International Convention for the Prevention of Pollution from Ships (MARPOL)
International Convention for the Safety of Life at Sea (SOLAS)
Protocol relating to Intervention on the High Seas in Cases of Pollution by Substances other than Oil
Convention Relating to Civil Liability in the Field of Maritime Carriage of Nuclear Material
International Plant Protection Convention
Convention on the Conservation of Antarctic Marine Living Resources
International Convention for the Prevention of Pollution of the Sea by Oil 1962 and 1969
Convention on the Prohibition of Military or any other Hostile Use of Environmental Modification Techniques
Convention on Fishing and Conservation of the Living Resources of the High Seas
Convention on the High Seas
Optional Protocol of Signature concerning the Compulsory Settlement of Disputes [Arising Out Of The United Nations Conference On The Law Of The Sea]
Convention on the Continental Shelf
Convention on Civil Liability for Nuclear Damage
Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space Moon and other Celestial Bodies

Treaty on the Prohibition of the Emplacement of Nuclear Weapons and other Weapons of Mass Destruction on the Sea-Bed and the Ocean Floor and in the
Treaty Banning Nuclear Weapon Tests in the Atmosphere Outer Space and under Water
Convention on the Prohibition of the Development Production and Stockpiling of Bacteriological (Biological) and Toxin Weapons and on their Destru
Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter
Fisheries Convention
Convention on Third Party Liability in the Field of Nuclear Energy
Convention on the Establishment of a Security Control in the Field of Nuclear Energy
Convention concerning the Protection of Workers against Occupational Hazards in the Working Environment due to Air Pollution
Convention concerning Protection against Hazards of Poisoning arising from Benzene (ILO No.136)
Convention concerning the Protection of Workers against Ionising Radiations (ILO No. 115)
The Antarctic Treaty
Agreement concerning Measures for the Protection of the Stocks of Deep Sea Prawns (Pandalus Borealis) Lobsters (Homarus Vulgaris) (Nephrops Norvegi
Convention on International Trade in Endangered Species of Wild Fauna and Flora
Convention on the Conservation of Migratory Species of Wild Animals
Convention for the International Council for the Exploration of the Sea
Convention concerning the Protection of the World Cultural and Natural Heritage
Convention on Wetlands of International Importance especially as Waterfowl Habitat
Protocol concerning Co-operation in combating Pollution in cases of Emergency
Agreement on an International Energy Program
Convention Supplementary to the Paris Convention of 29th July 1960 on Third Party Liability in the Field of Nuclear Energy as amended in 1964 and 1
Convention on the Liability of Operators of Nuclear Ships
International Convention relating to the Limitation of the Liability of Owners of Sea-going Ships
International Convention on Standards of Training Certification and Watchkeeping for Seafarers
United Nations Convention on the Law of the Sea
Amendments to the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter concerning Settlement of Disputes
Protocol to amend the Convention on Wetlands of International Importance especially as Waterfowl Habitat
International Tropical Timber Agreement
Agreement governing the Activities of States on the Moon and other Celestial Bodies
Protocol amending the Convention for the Prevention of Marine Pollution by Dumping from Ships and Aircraft
Convention for the Protection of the Ozone Layer
Convention on Conditions for Registration of Ships
Convention on Early Notification of a Nuclear Accident
Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency
Protocol amending the Convention for the prevention of marine pollution from land-based sources
Protocol on Substances that Deplete the Ozone Layer

International Convention for the Prevention of Pollution from Ships Hazardous substances carried in packaged form
International Convention for the Prevention of Pollution from Ships (MARPOL) - Annex IV (Optional): Sewage
International Convention for the Prevention of Pollution from Ships (MARPOL) - Annex V (Optional) = Garbage
Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal
Protocol relating to the International Convention for the Safety of Life at Sea (SOLAS PROT 1988)
Agreement on transboundary cooperation with a view to preventing or limiting harmfull effects for human beings property or the environment in the e
International Convention on Salvage
Protocol Concerning Specially Protected Areas and Wildlife to the Convention for the Protection and Development of the Marine Environment of the Wi
Protocol amending the Convention for the Prevention of Marine Pollution by Dumping from Ships and Aircraft
Amendment to the Convention on International Trade in Endangered Species of Wild Fauna and Flora (Art.XXI)
Amendments to Articles 6 and 7 of the Convention on Wetlands of International Importance especially as Waterfowl Habitat
Amendment to the Montreal Protocol on Substances that Deplete the Ozone Layer
Convention on Environmental Impact Assessment in a Transboundary Context
International Convention on Oil Pollution Preparedness Response and Co-operation
Protocol to the Antarctic Treaty on Environmental Protection
International Plant Protection Convention (1979 Revised Text)
Protocol concerning Marine Pollution resulting from Exploration and Exploitation of the Continental Shelf
Convention on the Protection and Use of Transboundary Watercourses and International Lakes
Convention on Transboundary Effects of Industrial Accidents
United Nations Framework Convention on Climate Change
Convention on Biological Diversity
Convention on the Prohibition of the Development Production and their Destruction
Convention for the Conservation of Anadromous Stocks
Amendment to the Montreal Protocol on Substances that Deplete the Ozone Layer
Regional Agreement on the transboundary movement of hazardous wastes
Convention concerning Safety in the Use of Asbestos
Protocol to amend the International Convention on the Establishment of an International Fund for Compensation for Oil Pollution Damage
Protocol to amend the International Convention on Civil Liability for Oil Pollution Damage
Agreement to Promote Compliance with International Conservation and Management Measures by Fishing Vessels on the High Seas
Agreement relating to the Implementation of Part XI of the United Nations Convention on the Law of the Sea of 10 December 1982
Agreement on Co-operative Enforcement Operations directed at Illegal Trade in Wild Fauna and Flora

International Convention to Combat Desertification in those Countries Experiencing Serious Drought and or Desertification
Convention on Nuclear Safety
Energy Charter Protocol on Energy Efficiency and related Environmental Aspects
Agreement for the Implementation of the Provisions of the United Nations Convention on the Law of the Sea relating to the Conservation and Manageme
Convention to ban the Importation into Forum Island Countries of Hazardous Wastes and Radioactive Wastes and to control the Transboundary Movement
Convention on the Law of the Non-Navigational Uses of International Watercourses
Protocol to the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter
Protocol to amend the Vienna Convention on Civil Liability for Nuclear Damage
Convention on Supplementary Compensation for Nuclear Damage
Convention on the Prohibition of the Use Production and Transfer of Anti-Personnel Mines and on their Destruction
Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management
Convention on Access to Information Public Participation in Decision-Making and Access to Justice in Environmental Matters
Comprehensive Nuclear Test - Ban Treaty
Statutes of the International Centre for Genetic Engineering and Biotechnology
International Plant Protection Convention (1997 Revised Text)
Amendment to the Montreal Protocol on Substances that Deplete the Ozone Layer

Table 6.14: List of treaties that Roberts et al. (2004) included in their analysis

Treatyname
International Convention On Civil Liability For Oil Pollution Damage
Convention On The Prevention Of Marine Pollution From Land-Based Sources
International Convention for the Regulation of Whaling
International Convention for the Prevention of Pollution of the Sea by Oil 1962 and 1969
Convention on Fishing and Conservation of the Living Resources of the High Seas
Convention on the High Seas
Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter
Convention on International Trade in Endangered Species of Wild Fauna and Flora
Convention on the Conservation of Migratory Species of Wild Animals
Convention on Long-Range Transboundary Air Pollution
Convention concerning the Protection of the World Cultural and Natural Heritage
Convention on Wetlands of International Importance especially as Waterfowl Habitat
Convention for the Protection of the Mediterranean Sea against Pollution
United Nations Convention on the Law of the Sea
Convention for the Protection of the Ozone Layer
Protocol on Substances that Deplete the Ozone Layer
Convention on Environmental Impact Assessment in a Transboundary Context
International Convention on Oil Pollution Preparedness Response and Co-operation
Convention on Transboundary Effects of Industrial Accidents
United Nations Framework Convention on Climate Change
Convention on Biological Diversity
International Convention to Combat Desertification in those Countries Experiencing Serious Drought and or Desertification

Bibliography

Abbott, K. W. & Snidal, D. (1998), 'Why States Act through Formal International Organizations', *Journal of Conflict Resolution* **42**, 3–32.

Allan, A. (2001), *The Middle East Water Question: Hydropolitics and the Global Economy*, Tauris, London.

Amery, H. & Wolf, A. (2000), *Water in the Middle East: A Geography of Peace*, University of Texas Press, Austin.

Appelgren, B. & Klohn, W. (1999), 'Management of Water Scarcity: A Focus on Social Capacities and Options', *Physics and Chemistry of the Earth, Part B: Hydrology, Oceans and Atmosphere* **24 (4)**, 361–373.

Araya, M. (2002), 'Environmental Benefits of Foreign Direct Investment: A Literature Review', *OECD Report, Working Party on Global and Sructural Policies* .

Armingeon, K., Careja, R., Potolidis, P., Gerber, M. & Leimgruber, P. (2008), 'Comparative Political Data Set III 1990–2006'. Institute of Political Science, University of Berne.

Aust, A. (2000), *Modern Treaty Law and Practice*, Cambridge University Press, Cambridge.

Axelrod, R. (1997), *The Complexity of Cooperation: Agent-based Models of Competition and Collaboration*, Princeton University Press, Princeton, NJ.

Axelrod, R. & Keohane, R. (1986), Achieving Cooperation under Anarchy: Strategies and Limitations, *in* K. A. Oye, ed., 'Cooperation under Anarchy', Princeton University Press, Princeton, NJ.

Bac, M. (1996), 'Incomplete Information and Incentives to Free Ride on International Environmental Resources', *Journal of Environmental Economics and Management* **30**, 301–315.

Baettig, M. B. & Bernauer, T. (2009), 'National Institutions and Global Public Goods: Are Democracies More Cooperative in Climate Change Policy', *International Organization* pp. 281–308.

Bannett, L. L., Ragland, S. E. & Yolles, P. (1998), Facilitating International Agreements Through an Interconnected Game: The Case of River Basins, *in* R. E. Just & S. Netanyahu, eds, 'Conflict and cooperation on trans-boundary water resources', Kluwer, pp. 61–84.

Barbieri, K. (n.d.), *The Liberal Illusion: Does Trade Promote Peace?*, University of Michigan Press, Ann Arbor.

Barrett, S. (1994), 'Conflict and Cooperation in managing International Water Resources', *Policy Research Working Paper* **1303**.

Beach, H. L., Hamner, J. & Hewitt, J. J. (2000), *Transboundary freshwater dispute resolution*, United Nations University Press, Tokyo, New York, Paris.

Beck, L., Bernauer, T. & Kalbhenn, A. (2009), 'Biases in International Environmental Datasets: Evidence from Water Quality Monitoring in Europe', *under review* . http://www.ib.ethz.ch/docs.

Beck, N., Gleditsch, K. S. & Beardsley, K. (2006), 'Space Is More than Geography: Using Spatial Econometrics in the Study of Political Economy', *International Studies Quarterly* **50**, 27–44.

Beck, N., Katz, J. N. & Tucker, R. (1998), 'Taking Time Seriously: Time-Series-Cross-Section Analysis with a Binary Dependent Variable', *American Journal of Political Science* **42(4)**, 1260–1288.

Bergin, M. S., West, J. J., Keating, T. J. & Russel, A. G. (2005), 'Regional Atmospheric Pollution and Transboundary Air Quality Management', *Annual Review of Environmental Resources* **30**, 1–37.

Bernauer, T. (1995), 'The Effect of International Environmental Institutions: How We Might Learn More', *International Organization* **49**, 351–377.

Bernauer, T. (1996), Protecting the River Rhine against Chloride Pollution, *in* R. Keohane & M. Levy, eds, 'Institutions for Environmental Aid: Pitfalls and Promise', MIT Press, Cambridge, Massachusetts, pp. 201–232.

Bernauer, T. (2002), 'Explaining Success and Failure in International River Management', *Aquatic Sciences* **64(1)**, 01–19.

Bernauer, T. & Caduff, L. (2004), 'In Whose Interest? Pressure Group Politics, Economic Competition and Environmental Regulation', *Journal of Public Policy* **24 (1)**, 99–126.

Bernauer, T. & Kalbhenn, A. (2009), The Politics of International Freshwater Resources, *in* R. A. Denemark, ed., 'The International Studies Compendium Project', Blackwell Publishing Ltd., Oxford, England. http://www.blackwellreference.com/public/isa_home.

Bernauer, T., Kalbhenn, A., Koubi, V. & Ruoff, G. (2009), 'International and Domestic Sources of Global Governance Dynamics: Explaining Global Environmental Treaty Ratifications, 1950-2000.', *British Journal of Political Science* **forthcoming**.

Bernauer, T. & Koubi, V. (2009), 'Effects of Political Institutions on Air Quality', *Ecological Economics* **68 (5)**, 1355–1365.

Bernauer, T. & Kuhn, P. (2009), 'Is There an Environmental Version of the Kantian Peace? Insights From Water Pollution in Europe', *Forthcoming in European Journal of International Relations* .

Beron, K. J., Murdoch, J. C. & Vijverberg, W. P. (2003), 'Why Cooperate? Public Goods, Economc Power, and the Montreal Protocol', *The Review of Economics and Statistics* **85 (2)**, 286–297.

Bhaduri, A. & Barbier, E. B. (2008), 'Political Altruism of Transboundary Water Sharing', *The B.E. Journal of Economic Analysis & Policy* **8 (1)**, 1–16.

Blatter, J. & Ingram, H., eds (2001), *Reflections on Water: New Approaches to Transboundary Conflicts and Cooperation*, MIT Press, Cambridge, Massachusetts.

Boehmer, C., Gartzke, E. & Nordstrom, T. (2004), 'Do International Organizations Promote Peace?', *World Politics* **57**, 1–38.

Brandt, P. T., Williams, J. T., Fordham, B. O. & Pollins, B. (2002), 'Dynamic Modeling for Persistent Event-Count Time Series', *American Journal of Political Science* **44 (4)**, 823–843.

Braun, D., Gilardi, F., Füglister, K. & Luyet, S. (2007), 'Ex Pluribus Unum: Integrating the Different Strands of Policy Diffusion Theory.', *Politische Vierteljahresschrift* **Sonderheft 38**, 39–55.

Braund, D. & Gilardi, F. (2006), 'Taking 'Galton's Problem' Seriously', *Journal of Theoretical Politics* **18 (3)**, 289–322.

Brochmann, M. & Gleditsch, N. P. (2006), 'Conflict, Cooperation, and Good Governance in International River Basins', *Paper presented to the International Workshop 'Governance and the Global Water System: Institutions, Actors, Scales of Water Governance Facing the Challenges of Global Change', 20-23 June 2006* . `www.prio.no/files/file48311_marit_brochmann_paper.pdf`, consulted October 27th 2006.

Brochmann, M. & Gleditsch, N. P. (2006b), 'Shared rivers and international cooperation', *Paper presented at the 47th ISA Annual Convention, San Diego* .

Brochmann, M. & Hensel, P. R. (2009*a*), 'Peaceful Management of International River Claims', *International Negotiation* **14(2)**, 393–418.

Brochmann, M. & Hensel, P. R. (2009*b*), 'The Effectiveness of Negotiations over International River Claims'. paper presented at the Annual Meeting of the International Studies Association, New York, 16 February 2009.

Bueno de Mesquita, B., Smith, A., Siverson, R. M. & Morrow, J. D. (2003), *The Logic of Political Survival*, MIT Press, Cambridge, Massachusetts; London, England.

Bulloch, J. & Darwish, A. (1993), *Water Wars: Coming Conflicts in the Middle East*, Victor Gollancz, London.

Büthe, T. & Milner, H. V. (2008), 'The Politics of Foreign Direct Investment into Developing Countries: Increasig FDI through International Trade Agreements?', *American Journal of Political Science* **52 (4)**, 741–762.

Carraro, C. & Marchiori, C. (2003), 'Endogenous Strategic Issue Linkage in International Negotiations', *Working Paper* . `http://www.feem.it/web/activ/_wp.html`, consulted January 12th 2007.

Carter, D. B. & Signorino, C. (2009), 'Back to the future: Modeling Time Dependence with binary Data'. Working Paper.

Carter, D. B. & Signorino, C. S. (2007), 'Back to the future: Modeling Time Dependence with binary Data', *Working Paper* .

Chapman, J., ed. (1963), *The International River Basin: Seminar in the development and administration of the international river basin*, University of British Columbia, Vancouver.

CIESIN (2006), 'Environmental Treaties and Resource Indicators (ENTRI)'. `http://sedac.ciesin.columbia.edu/entri/`, consulted December 13th 2006.

Conca, K. (2006), *Governing Water: Contentious Transnational Politics and Global Institution Building*, MIT Press, Cambridge, Massachusetts.

Conca, K., Wu, F. & Mei, C. (2006*a*), 'Global Regime Formation or Complex Institution Building? The Principled Content of International River Agreements', *International Studies Quarterly* **50(2)**, 263–285.

Conca, K., Wu, F. & Mei, C. (2006*b*), 'Global Regime Formation or Complex Institution Building? The Principled Content of International River Agreements', *International Studies Quarterly* **50(2)**, 263–285.

Congleton, R. D. (1992), 'Political Institutions and Pollution Control', *Review of Economics and Statistics* **74(3)**, 412–421.

Cooley, J. (1984), 'The War over Water', *Foreign Policy* **54**, 3–26.

Correlates of War Project (2008), 'State System Membership List, v2008.1'. `http://correlatesofwar.org`.

Crescenzi, M. J. C. & Enterline, A. J. (2001), 'Time Remembered: A Dynamic Model of Interstate Interaction', *International Studies Quarterly* **45**, 409–431.

Cusack, T. R. & Fuchs, S. (2002), 'Documentation Notes for Parties, Governments, and Legislatures Data Set'. `http://www.wzb.eu/alt/ism/people/misc/cusack/d_sets.en.htm#data`, consulted November 4th 2009.

Daoudy, M. (2009), 'Asymmetric Power: Negotiating Water in the Euphrates and Tigris', *International Negotiation* **14(2)**, 361–391.

Deacon, R. (1999), 'The Political Economy of Environment-Development Relationships: A Preliminary Framework', *Working Paper* . `http://repositories.cdlib.org/ucsbecon/dwp/wp11-99`, consulted May 27th 2006.

Dinar, A. & Dinar, S. (2003), 'Recent Developments in the Literature on Conflict and Cooperation in International Shared Water', *Natural Resources Journal* **43 (4)**, 1217–1287.

Dinar, A., Dinar, S. & McCaffrey, S. (2007), *Bridge over Water: Understanding Transboundary Water Conflict, Negotiation and Cooperation*, World Scientific Publishing, Singapore.

Dinar, S. (2000), 'Negotiations in International Relations: A Framework for Hydropolitics', *International Negotiation* **5 (2)**, 375–407.

Dinar, S. (2006), 'Assessing Side-Payments and Cost-Sharing Patterns in International Water Agreements: The Geographic and Economic Connection', *Political Geography* **25**, 412–437.

Dinar, S. (2008), *International Water Treaties: Negotiation and Cooperation along Transboundary Rivers*, Routledge, Abingdon.

Dinar, S. (2009*a*), 'Power Asymmetry and Negotiations in International River Basins', *International Negotiation* **14 (2)**, 329–360.

Dinar, S. (2009*b*), 'Scarcity and Cooperation Along International Rivers', *Global Environmental Politics* **9**(1), 109–135.

Dinar, S., Dinar, A. & Kurukulasuriya, P. (n.d.), 'Scarcity and Cooperation Along International Rivers: An Empirical Assessment of Bilateral Treaties'.

Dombrowsky, I. (2006), 'Integration in the Management of International Waters: Policy Discourse, Theory Predictions and Empirical Evidence'. Paper presented at the International Workshop "Governance and the Global Water System", Bonn, June 20–23, 2006.

Dombrowsky, I. (2007), *Conflict, Cooperation and Institutions in International Water Management: An Economic Analysis*, Edward Elgar, Cheltenham.

Dorussen, H. & Ward, H. (2005), 'Trade Links and the Kantian Peace: A Network-Theoretic Approach to Communication, Intercultural Understanding, and Conflict', *Working Paper* . presented at the APSA 2006 in Philadelphia.

Dorussen, H. & Ward, H. (2006), 'Trade Links and the Kantian Peace: A Network-Theoretic Approach to Communication, Inter-Cultural Understanding, and Conflict.'. paper presented at the 102nd meeting of the American Political Science Association, Philadelphia, 2006.

Dorussen, H. & Ward, H. (2008), 'Intergovernmental Organizations and the Kantian Peace', *Journal of Conflict Resolution* **52 (2)**, 189–212.

Drezner, D. (1998), 'Globalizers of the World, Unite!', *Washington Quarterly* **21 (1)**, 207–225.

Drieschova, A., Giordano, M. & Fischhendler, I. (2008), 'Governance Mechanisms to Address Flow Variability in Water Treaties', *Global Environmental Change* **18**, 285–295.

Durth, R. (1996), *Grenzüberschreitende Umweltprobleme und regionale Integration: Zur Politischen Oekonomie von Oberlauf-Unterlauf-Problemen an internationalen Flüssen*, Nomos Verlag, Baden-Baden.

Elhance, A. (1999), *Hydropolitics in the Third World: Conflict and Cooperation in International River Basins*, US Institute of Peace Press, Washington, D.C.

Elhorst, J. P. (2003), 'Specification and Estimation of Spatial Panel Data Models', *International Regional Science Review* **26 (3)**, 244–268.

Elkins, Z., Guzman, A. & Simmons, B. (2006), 'Competing for Capital: the Diffusion of Bilateral Investment Treaties, 1960–2000', *International Organization* **60 (4)**, 811–846.

Elkins, Z. & Simmons, B. (2005), 'On Waves, Clusters and Diffusion: A Conceptual Framework', *Annuals of the American Academy of Political and Social Sciences* **598**, 33–51.

Espey, M. & Towfique, B. (2004), 'International Bilateral Water Treaty Formation', *Water Resources Research* **40: W05S05**.

Fearon, J. D. (1994), 'Domestic Political Audience and the Escalation of International Disputes', *American Political Science Review* **88 (3)**, 577–592.

Fox, I. & Le Marquand, D. (1978), International River Basin Cooperation, *in* A. Biswas, ed., 'United Nations Water Conference: Summary and Main Documents (Mar Del Plata). Water Development, Supply and Management', Pergamon Press, Oxford, pp. 1041–1061.

Frank, D. J. (1999), 'The Social Bases of Environmental Treaty Ratification, 1900-1990', *Sociological Inquire* **69 (4)**, 523–550.

Franzese, R. J. J. & Hays, J. C. (2007), 'Spatial Econometric Models of Cross-Sectional Interdependence in Political Science Panel and Time-Series-Cross-Sectin Data', *Political Analysis* **15**, 140–164.

Franzosi, R. (2004), *From Words to Numbers: Narrative, Data, and Social Science*, Cambridge University Press, Cambridge.

Fredriksson, P. G. & Gaston, N. (2000), 'Ratification of the 1992 Climate Change Convention: What Determines Legislative Delay?', *Public Choice* **104**, 345–368.

Fredriksson, P. G. & Ujhelyi, G. (2006), 'Political Institutions, Interest Groups, and the Ratification of International Environmental Agreements', *Working Paper* .

Fredriksson, P. G. & Wollscheid, J. (2007), 'Democratic Institutions versus Autocratic Regimes: The Case of Environmental Policy', *Public Choice* **130**, 381–393.

FreedomHouse (2008), 'Methodology'. `http://www.freedomhouse.org/template.cfm?page=351&ana_page=341&year=2008`.

Frey, F. (1993), 'The Political Context of Conflict and Cooperation over International River Basins', *Water International* **18**, 54–68.

Furlong, K., Gleditsch, N. P. & Hegre, H. (2006), 'Geographic Opportunity and Neomalthusian Willingness: Boundaries, Shared Rivers, and Conflict', *International Interactions* **32**, 79–108.

Ganoulis, J., Duckstein, L., Literathy, P. & Bogardi, I., eds (1996), *Transboundary Water Resources Management*, Springer, Berlin.

Ganser, A. (2007), 'Grenzüberschreitende Wasserverschmutzung in Europa: Lagebeurteilung von grenznahen Messstationen', *Semester thesis at CIS, ETH Zurich* .

Gartzke, E. (2008), 'The Capitalist Peace', *American Journal of Political Science* **51**, 166–191.

Gartzke, E. & Jo, D.-J. (2002), *The Affinity Of Nations Index*. Version 3.0.

Gaubatz, K. T. (1996), 'Democratic States and Commitment in International Relations', *International Organization* **50 (1)**, 109–139.

Gerlak, A. K. & Grant, K. A. (2009), The Correlates of Cooperative Institutions for International Rivers, *in* T. J. Volgy, Z. Šabič & A. K. Gerlak, eds, 'Mapping the New World Order', Wiley-Blackwell Publishers, pp. 114–147.

Giordano, M. A. (2002), 'International River Basin Management: Global Principles and Basin Practice', *PhD Dissertation, Oregon State University* .

Gizelis, T., Powers, K. & Wooden, A. (2007), 'With a Little Help from My Friends: International Water Cooperation and Civil Conflict', *Paper presented at the annual meeting of the International Studies Association 48th Annual Convention, Hilton Chicago* . `http://www.allacademic.com/meta/p179911_index.html`, consulted April 20th 2009.

Gleditsch (2006), 'Expanded Trade and GDP Dataset'.

Gleditsch, K. S. (2002), 'Expanded Trade and GDP Data', *Journal of Conflict Resolution* **46**, 712–724.

Gleditsch, K. S. (2008), 'Modified Polity P4 and P4D Data, Version 3.0'. `http://weber.ucsd.edu/~kgledits/Polity.html`, consulted March 20th 2009.

Gleditsch, N. P., Furlong, K., Hegre, H., Lacina, B. & Owen, T. (2006), 'Conflicts over Shared Rivers: Resource Scarcity or Fuzzy Boundaries?', *Political Geography* **25**, 361–382.

Gleick, H. (1998–2009), *The World's Water: The Biennial Report on Freshwater*, Island Press, Washington, D.C.

Gleick, H., Wolff, G. & Heather, C. (2006), *The World's Water 2006-2007: The Biennial Report on Freshwater Resources*, Island Press, Washington, D.C.

Gleick, P. H. (1993), 'Water and Conflict: Fresh Water Resources and International Security', *International Security* **18(1)**, 79–112.

Gleick, P. H. (1998), *The World's Water*, Island Press.

Goertz, G. (2006), A checklist for constructing, evaluating, and using concepts or quantitative measures, *in* J. Box-Steffensmier, H. Brady & D. Collier, eds, 'The Oxford Handbook of Political Methodology', Oxford University Press, Oxford.

Grossman, G. M. & Krueger, A. B. (1995), 'Economic Growth and the Environment', *The Quarterly Journal of Economics* **110(2)**, 353–377.

Guerin, S. & Manzocchi, S. (2006), 'When FDI Flows from Rich to Poor Countries: Do Democracy and Economic Reform Matter?', *CEPS Working Document* **251**.

Haas, E. (1964), *Beyond the Nation-State*, Stanford University Press, Stanford.

Haas, P. M., Keohane, R. O. & Levy, M. A. (1993), *Institutions for the Earth: Sources of Effective International Environmental Protection*, MIT Press, Cambridge, MA.

Hafner-Burton, E. M., von Stein, J. & Gartzke, E. (2008), 'International Organizations Count', *Journal of Conflict Resolution* **52 (2)**, 175–188.

Hamner, J. (2009), 'Drought and "Hydro-Cooperation"', *presented at the 2009 Annual Meeting of the International Studies Association* .

Harbom, L., Melander, E. & Wallensteen, P. (2008), 'Dyadic Dimensions of Armed Conflict, 1946-2007', *Journal of Peace Research* **45(5)**, 697–710.

Hayes, A. F. & Krippendorff, K. (2007), 'Answering the Call for a Standard Reliability Measure for Coding Data', *Communication Methods and Measures* **1 (1)**, 77–89.

Hays, J. C., Kachi, A. & Franzese, R. J. J. (2009), 'An m-STAR Model of Dynamic, Endogenous Interdependence – a.k.a. Network-Behavior Coevolution – in the Social Sciences'.

Henisz, W. J., Zelner, B. A. & Guillen, M. F. (2005), 'International Coercion, Emulation and Policy Diffusion: Market-Oriented Infrastructure Reforms, 1977–1999', *American Sociological Review* **70**, 871–891.

Hensel, P. R. (2005), 'Codebook for River Claims Data. Issue Correlates of War (ICOW) Project'. `http://garnet.acns.fsu.edu/~phensel/icow.html`.

Hensel, P. R. & Brochmann, M. (2007), 'Armed conflict over international rivers: The onset and militarization of river claims', *Paper presented at the 48th ISA Annual Convention, Chicago* .

Hensel, P. R., Mitchell, S. M. & Sowers, T. (2006), 'Conflict management of riparian disputes', *Political Geography* **25**, 383–411.

Hensel, P. R., Mitchell, S. M., Sowers, T. E. & Thyne, C. (2008), 'Bones of Contention: Comparing Territorial, Maritime, and River Issues', *Journal of Conflict Resolution* **52 (1)**, 117–143.

Heston, A., Summers, R. & Aten, B. (2006), *Penn World Table Version 6.2*, Center for International Comparisons of Production, Income and Prices at the University of Pennsylvania.

Hodson, R. (1999), *Analyzing Documentary Accounts*, number 128 *in* 'Quantitative Applications in the Social Science', Sage Publications, Thousand Oaks.

Hoffman, K. A. (2003), 'On Water and Power: The Determinants of International Cooperation Over Shared River Basins'. Paper submitted to the 2003 American Sociological Association Meetings in Atlanta, Georgia.

Holtrup, P. (1999), 'Der Schutz grenzüberschreitender Flüsse in Europa. Zur Effektivität internationaler Umweltregime', *PhD Dissertation, University of Bonn, Forschungszentrum Jülich* .

Homer-Dixon, T. (1994), 'Environmental Scarcities and Violent Conflict: Evidence From Cases', *International Security* **19 (1)**, 5–40.

Hovi, J., Sprinz, D. & Underdal, A. (2003*a*), 'Regime Effectiveness and the Oslo–Potsdam Solution: A Rejoinder to Oran Young', *Global Environmental Politics* **3 (3)**, 105–107.

Hovi, J., Sprinz, D. & Underdal, A. (2003*b*), 'The Oslo–Potsdam Solution to Measuring Regime Effectiveness: Critique, Response, and the Road Ahead', *Global Environmental Politics* **3 (3)**, 74–96.

Howell, P. & Allan, J., eds (1994), *The Nile: Sharing a Scarce Resource. A Historical and Technical Review of Water Management and of Economic and Legal Issues*, Cambridge University Press, Cambridge, Massachusetts.

Hughes Butts, K. (1997), 'The Strategic Importance of Water', *Parameters* **28**(1), 65–83.

Ingram, H. & Blatter, J. (2000), 'States, Markets and Beyond: Governance of Transboundary Water Resources', *Water Resources Journal* **40**, 439–473.

IUCN (n.d.), 'eAtlas: Watersheds of the World'. `http://www.iucn.org/about/work/programmes/water/wp_resources/wp_resources_eatlas/`.

Jaggers, K. & Gurr, T. R. (1995), 'Tracking Democracy's Third Wave with the Polity III Data', *Journal of Peace Research* **32 (4)**, 469–482.

Jahn, D. (1998), 'Environmental Performance and Policy Regimes: Explaining Variations in 18 OECD-Countries', *Policy Sciences* **31**, 107–131.

Jahn, D. (2006*a*), *Einführung in die vergleichende Politikwissenschaft*, VS Verlag f¸r Sozialwissenschaften, Wiesbaden.

Jahn, D. (2006*b*), 'Globalization as 'Galton's Problem': The Missing Link in the Analysis of Diffusion Patterns in Welfare State Development', *International Organization* **60 (2)**, 401–431.

Jahn, D. (2008), 'The Politics of Climate Change', *Paper presented at the ECPR conference, April 2008, Rennes (France)* .

Jørgensen, S. & Zaccour, G. (2001), 'Time Consistent Side Payments in a Dynamic Game of Downstream Pollution', *Journal of Economic Dynamics & Control* **25**, 1973–1987.

Jorgenson, A. K. (2009*a*), 'Foreign Direct Investment and the Environment, the Mitigating Influence of Institutional and Civil Society Factors, and Relationships between Industrial Pollution and Human Health. A Panel Study of Less-Developed Countries', *Organization and Environment* **22 (2)**, 135–157.

Jorgenson, A. K. (2009*b*), 'Political-Economic Integration, Industrial Pollution and Human Health: A Panel Study of Less-Developed Countries, 1980-2000', *International Sociology* **24 (1)**, 115–143.

Kalbhenn, A. (2009*a*), 'A River Runs Through It. Democracy, International Interlinkages and Cooperation over Shared Resources', *NCCR Working Paper* **35**.

Kalbhenn, A. (2009*b*), 'Transboundary Waters – A new Event Data Set'.

Kempkey, N., Pinard, M., Pochat, V. & Dinar, A. (2009), 'Negotiations Over Water and Other Natural Resources in the La Plata River Basin: A Model for Other Transboundary Basins?', *International Negotiation* **14 (2)**, 253–279.

Keohane, R. (1984), *After Hegemony: Cooperation and Discord in the World Political Economy*, Princeton University Press, Princeton, NJ.

Keohane, R. & Nye, J. (1977), *Power and Interdependence*, Little Brown and Company, Boston.

Kibaroglu, A. (2002), *Building a Regime for the Waters of the Euphrates–Tigris River Basin*, Aspen, New York.

Kilgour, M. & Dinar, A. (1995), 'Are Stable Agreements for Sharing International River Waters Now Possible?', *World Bank Policy Research Working Paper* **1474**.

King, G., Tomz, M. & Wittenberg, J. (2000), 'Making the Most of Statistical Analyses: Improving Interpretation and Presentation', *American Journal of Political Science* **44(2)**, 347–361.

King, G. & Zeng, L. (1999), 'Logistic Regression in Rare Events Data', *Department of Government, Harvard University* . `http://gking.harvard.edu`.

Krippendorff, K. (2004*a*), *Content Analysis: An Introduction to its Methodology*, Thousand Oaks, Sage Publications.

Krippendorff, K. (2004*b*), 'Measuring the Reliability of Qualitative Text Analysis Data', *Quality and Quantity* **38**, 787–800.

Lake, D. & Baum, M. (2001), 'The Invisible Hand of Democracy: Political Control and the Provision of Public Service', *Comparative Political Studies* **34 (6)**, 587–621.

Layne, C. (1994), 'Kant or Cant: The Myth of the Democratic Peace', *International Security* **19(2)**, 5–49.

Le Marquand, D. (1977), *International Rivers: The Politics of Cooperation*, Westwater Research Center, Vancouver.

Lee, D. & Dinar, A. (1995), 'Review of Integrated Approaches to River Basin Planning, Development and Management', *World Bank Policy Research Working Paper* **1446**.

Leeds, B. A. (1999), 'Domestic Political Institutions, Credible Commitments and International Cooperation', *American Journal of Political Science* **43 (4)**, 979–1002.

Levi-Faur, D. (2005), 'The Global Diffusion of Regulatory Capitalism', *Annuals of the American Academy of Political and Social Sciences* **598**, 12–33.

Levy, G. & Razin, R. (2004), 'It Takes Two: An Explanation for the Democratic Peace', *Journal of the European Economic Association March 2004* **02 (01)**, 01–29.

Li, Q. & Reuveny, R. (2006), 'Democracy and Environmental Degradation', *International Studies Quarterly* **50**, 935–956.

Long, J. S. (1997), *Regression Models for Categorical and Limited Dependent Variables*, Sage, Thousand Oaks.

Lowi, M. (1993*a*), *Water and Power: The Politics of a Scarce Resource in the Jordan River Basin*, Cambridge University Press, New York.

Lowi, M. R. (1993*b*), *Water and Power. The Politics of a Scarce Resource in the Jordan River Basin*, Cambridge University Press, Cambridge.

Mandel, R. (1992), 'Sources of International River Basin Disputes', *Conflict Quarterly* **12**, 25–56.

Mansfield, E. D., Milner, H. V. & Rosendorff, P. B. (2002), 'Why Democracies Cooperate More: Electoral Control and International Trade Agreements', *International Organization* **56(3)**, 477–513.

Maoz, Z. & Russett, B. M. (1993), 'Normative and Structural Causes of Democratic Peace, 1946–1986', *American Political Science Review* **87(3)**, 624–638.

Marshall, M. G. & Jaggers, K. (2002), *Polity IV Project: Political Regime Characteristics and Transitions, 1800-2002*. Dataset Users' Manual.

Martin, L. (2000), *Democratic Commitments: Legislatures and International Cooperation*, Princeton University Press, Princeton, NJ.

Marty, F. (1997), 'International River Management: The Political Determinants of Success and Failure', *University of Zurich, Studien zur Politikwissenschaft* **305**.

Marty, F. (2001), *Managing International Rivers: Problems, Politics and Institutions*, Peter Lang, Bern.

McGuire, M. & Olson, M. (1996), 'The Economics of Autocracy and Majority Rule: the Invisible Hand and the Use of Force', *Journal of Economic Literature* **34 (2)**, 72–96.

Mercer, J. (1996), *Reputation and International Politics*, Cornell University Press, Ithaca, NY.

Meseguer, C. (2005), 'Policy Learning, Policy Diffusion and the Making of a New Order', *Annuals of the American Academy of Political and Social Sciences* **598**, 67–82.

Meseguer, C. (2006), 'Learning and Economic Policy Choices', *European Journal of Political Economy* **22**, 156–178.

Meyer, J. W., Frank, D. J., Hironaka, A., Schofer, E. & Tuma, N. (1997), 'The Structuring of a World Environmental Regime', *International Organization* **51 (4)**, 623–651.

Midlarsky, M. (1998), 'Democracy and the Environment: An Empirical Assessment', *Journal of Peace Research* **35 (3)**, 341–361.

Mitchell, R. B. (1994), 'Regime Design Matters: Intentional Oil Pollution and Treaty Compliance', *International Organization* **48 (3)**, 425–458.

Mitchell, R. B. (2002), International Environment, *in* T. Risse, B. Simmons & W. Carlsnaes, eds, 'Handbook of International Relations', Sage, pp. 500–516.

Mitchell, R. B. (2002-2008*b*), 'International Environmental Agreements Database Project (Version 2007.1'. `http://iea.uoregon.edu/`, consulted March 18th 2008.

Mitchell, R. B. (2008*a*), 'International Environmental Agreements Database Project, Version 2007.1'. http://iea.uoregon.edu/, consulted March 18th 2008.

Mitchell, S. M. & Hensel, P. R. (2007), 'International Institutions and Compliance with Agreements', *American Journal of Political Science* **51 (4)**, 721–731.

Mitchell, T. D. (2004), 'An improved method of constructing a database of monthly climate observations and associated high resolution grids'. http://www.cru.uea.ac.uk/~timm/grid/CRU_TS_2_1.html, consulted March 20th 2009.

Mitrany, D. (1966), *A Working Peace System*, Quadrangle, Chicago.

Murdoch, J. C., Sandler, T. & Vijverberg, W. P. (2003), 'The Participation Decision versus the Level of Participation in an Environmental Treaty: a Spatial Probit Analysis', *Journal of Public Economics* **87**, 337–362.

Nakayama, M. (1997), 'Successes and Failures of International Organizations in Dealing with International Waters', *Water Resources Development* **13**, 367–382.

Neumayer, E. (2002*a*), 'Do Democracies Exhibit Stronger International Environmental Commitment? A Cross-Country Analysis', *Journal of Peace Research* **39 (2)**, 139–164.

Neumayer, E. (2002*b*), 'Does Trade Openness Promote Multilateral Environmental Cooperation?', *The World Economy* **25(6)**, 815–812.

Neumayer, E. & De Soya, I. (2005), 'False prophet, or genuine savior? Assessing the effects of economic openness on sustainable development, 1980-1999.', *International Organization* **59**, 731–772.

Niskanen, W. (1997), 'Autocratic, Democratic and Optimal Government', *Economic Inquiry* **35 (3)**, 464–479.

OECD (2008), *Direct Investment by Country 2008*, ESDS International, (Mimas), University of Manchester.

Olson, M. (1993), 'Dictatorship, Democracy and Development', *American Political Science Review* **87 (3)**, 567–576.

Oneal, J. R. & Ray, J. L. (1997), 'New Tests of the Democratic Peace: Controlling for Economic Interdependence 1950–85', *Political Research Quarterly* **50(4)**, 751–775.

Oneal, J. R. & Russett, B. (1999), 'Assessing the Liberal Peace with Alternative Specifications: Trade Still Reduces Conflict', *Journal of Peace Research* **36**, 423–442.

Oneal, J. R. & Russett, B. M. (1997), 'The Classical Liberals Were Right: Democracy, Interdependence, and Conflict, 1950–1985', *International Studies Quarterly* **41(2)**, 267–294.

Owen, T., Furlong, K. & Gleditsch, N. P. (2004), 'Codebook for The Shared River Basin GIS and Database'. http://www.prio.no/CSCW/Research-and-Publications/Project/?oid=64378, consulted July 13th 2009.

Payne, R. A. (1995), 'Freedom and the Environment', *Journal of Democracy* **6(3)**, 41–55.

Petrosjan, L. A. & Zaccour, G. (1996), 'A Multistage Supergame of Downstream Pollution', **31 (314)**, 833–837.

Pevehouse, J. C., Nordstrom, T. & Warnke, K. (2004*a*), 'The COW-2 International Organizations Dataset Version 2.0', *Conflict Management and Peace Science* **21**, 101–119.

Pevehouse, J., Nordstrom, T. & Warnke, K. (2004*b*), 'Intergovernmental Organizations. 1815-2000: A New Correlates of War Data Set'. `http://cow2.la.psu.edu/`.

Prakash, A. & Potoski, M. (2006), 'Racing to the Bottom? Trade, Environmental Governance, and ISO 14001', *American Journal of Political Science* **50 (2)**, 350–364.

Rabe-Hesketh, S. & Skrondal, A. (2008), *Multilevel and Longitudinal Modeling using Stata*, Stata Press, Texas.

Rangeley, R. (1994), 'International River Basin Organizations in Sub-Saharan Africa', *World Bank* .

Recchia, S. (2001), 'Explaining the International Environmental Cooperation of Democratic Countries', *Working Paper* . `http://repositories.cdlib.org/csd/01-02`, consulted September 1st 2006.

Rieckermann, J., Daebel, H., Ronteltap, M. & Bernauer, T. (2006), 'Assessing the Performance of International Water Management at Lake Titicaca', *Aquatic Sciences* **68 (4)**, 502–516.

Roberts, T. J., Parks, B. C. & Vásqeuz, A. A. (2004), 'Who Ratifies Environmental Treaties and Why? Institutionalism, Structuralism and Participation by 192 Nations in 22 Treaties', *Global Environmental Politics* **4(3)**, 22–64.

Rosendorff, B. P. & Vreeland, J. R. (2006), 'Democracy and Data Dissemination: The Effect of Political Regime on Transparency'.

Rothman, S. B. (2007), 'Understanding Data Quality through Reliability: A Comparison of Data Reliability Assessment in Three International Relations Datasets', *International Studies Review* **9**, 437–456.

Ruoff, G. (2009*a*), 'Grow Rich and Clean Up Later? Joint Effects of International Integration and Democracy on Environmental Performance', *NCCR Working Paper* **33**. `http://www.nccrdemocracy.uzh.ch/nccr/publications/workingpaper/workingpaper.33`, consulted December 10th 2009.

Ruoff, G. (2009*b*), 'Grow Rich and Clean Up Later? Joint Effects of International Integration and Democracy on Environmental Performance', *PhD Dissertation, CIS, ETH Zurich, Switzerland* .

Russet, B. (1993), *Grasping the Democratic Peace: Principles for a Post-Cold War World*, Princeton University Press, Princeton.

Russett, B. M. (1994), *Grasping the democratic peace: principles for a post-Cold War world*, Princeton University Press, Princeton.

Russett, B. & Oneal, J. (2001), *Triangulating Peace: Democracy, Interdependence, and International Organizations*, Norton, New York.

Salman, S. & Boisson-de-Chazournes, L. (1998), 'International Watercourses: Enhancing Cooperation and Managing Conflict. Proceedings of a World Bank seminar', *World Bank Technical Paper* **414**.

Schneider, G., Barbieri, K. & Gleditsch, N. P., eds (2003), *Globalization and Armed Conflict*, Rowman and Littlefield, Lanham, MD.

Selden, T. M. & Song, D. (1994), 'Environmental Quality and Development: Is There a Kuznets Curve for Air Pollution Emissions?', *Journal of Environmental Economics and Management* **27**, 147–162.

Shipan, C. & Volden, C. (2008), 'The Mechanisms of Policy Diffusion', *American Journal of Political Science* **52 (4)**, 840–857.

Shmueli, D. (1999), 'Water Quality in International River Basins', *Political Geography* **18**, 437–476.

Siegfried, T. & Bernauer, T. (2007), 'Estimating the Performance of International Regulatory Regimes: Methodology and Empirical Application to International Water Management in the Naryn/Syr Darya Basin', *Water Resources Research* **43**.

Sigman, H. (2002), 'International Spillovers and Water Quality in Rivers: Do Countries Free Ride?', *American Economic Review* **92(4)**, 1152–1159.

Sigman, H. (2003), 'International Trade and Pollution in Shared Rivers: A Study of International Rivers', *Contributions to Economic Analysis & Policy* **3 (2)**. `http://www.bepress.com/bejeap/contributions/vol3/iss2/art2`, consulted January 03rd 2007.

Sigman, H. (2004), 'Does Trade Promote Environmental Coordination? Pollution in International Rivers', *Contributions to Economic Analysis & Policy Policy* **3 (2)**. `http://www.bepress.com/bejeap/contributions/vol3/iss2/art2/`, consulted September 22nd 2006.

Simmons, B. (1993), 'Credibility, Costs and Institutions: Cooperation on Economic Sanctions', *World Politics* **45 (3)**, 406–432.

Simmons, B. (2000), 'International Law and State Behavoir: Commitment and Compliance in International Monetary Affairs', *American Political Science Review* **94 (4)**, 819–836.

Simmons, B. A., Dobbin, F. & Garrett, G. (2006), 'Introduction: The International Diffusion of Liberalism', *International Organization* **60 (4)**, 781–810.

Simmons, B. A. & Elkins, Z. (2004), 'The Globalization of Liberalization: Policy Diffusion in the International Political Economy', *American Political Science Review* **98 (1)**, 171–188.

Singer, J. D., Bremer, S. & Stuckey, J. (1972), Capability Distribution, Uncertainty, and Major Power War, 1820-1965, *in* B. Russett, ed., 'Peace, War, and Numbers', Sage, Beverly Hills, CA, pp. 19–48.

Slantchev, B. L. (2006), 'Politicians, the Media, and Domestic Audience Costs', *International Studies Quarterly* **50 (3)**, 445–477.

Song, J. & Whittington, D. (2004), 'Why have some countries on international rivers been successful negotiating treaties? A global perspective', *Water Resources Research* **40**(W05S06).

Sprinz, D. & Helm, C. (2000), 'Measuring the Effectiveness of International Environmental Regimes', *Journal of Conflict Resolution* **44 (5)**, 630–652.

Sprinz, D. & Vaahoranta, T. (1994), 'The Interest-Based Explanation of International Environmental Policy', *International Organization* **48 (1)**, 77–106.

Starr, J. R. (1991), 'Water Wars', *Foreign Policy* **82**, 17–36.

Stern, D. I. (2005), 'Global Sulfur Emissions from 1850 to 2000', *Chemosphere* **58**, 163–175.

Stinnett, D. M. & Tir, J. (2009*a*), 'The Institutionalization of River Treaties', *International Negotiation* **14 (2)**, 229–251.

Stinnett, D. & Tir, J. (2009*b*), 'The Formation of River Monitoring Institutions', *International Negotiation* **14 (2)**, 229–251.

Stroh, K. (2004), 'Konflikt und Kooperation um Wasser. Eine Fallstudie über den Nil', *Arbeitspapiere Forschungsstelle Dritte Welt, Ludwig Maximilians University* .

Stucki, P. (2005), 'Water Wars or Water Peace? Rethinking the Nexus between Water Scarcity and Armed Conflict', *PSIS Occasional Paper 3/2005, Programme for Strategic and International Security Studies* .

Taylor, M. & Ward, H. (1982), 'Chickens, Whales, and Lumpy Goods: Alternative Models of Public-Goods Provision', *Political Studies* **30 (3)**, 350–370.

Tir, J. & Ackerman, J. (2009), 'Politics of Formalized River Cooperation', *Journal of Peace Research* **46 (5)**, |forthcoming.

Tomz, M., King, G. & Zeng, L. (1999), 'RELOGIT: Rare Events Logistic Regression', *Cambridge MA: Harvard University* **Version 1.1.** `http://gking.harvard.edu`.

Tomz, M., Wittenberg, J. & King, G. (2001), 'CLARIFY: Software for Interpreting and Presenting Statistical Results', *MA: Harvard University* **Version 2.0**. `http://gking.harvard.edu`.

Torras, M. & Boyce, J. K. (1998), 'Income, Inequality, and Pollution: a Reassessment of the Environmental Kuznets Curve', *Ecological Economics* **25**, 147–160.

Toset, H. P. W., Gleditsch, N. P. & Hegre, H. (2000), 'Shared rivers and interstate conflict', *Political Geography* **19 (8)**, 971–996.

Trivedi, P. K. & Munkin, M. K. (2009), 'Recent Developments in Cross Section and Panel Count Models'. working paper.

Tschanz, R. (2001), 'Gewässerschutz am Rhein: Zur Lösung von grenzüberschreitenden Umweltschutzproblemen', *MA thesis, Swiss Federal Institute of Technology (ETH), Zurich* .

Underdal, A. (1992), 'The concept of regime "effectiveness"', *Cooperation and Conflict* **27 (3)**, 227–40.

United Nations (1975), *Management of International Water Resources: Institutional and Legal Aspects*, United Nations, New York.

Vanhanen, T. (2000a), 'A new dataset for measuring democracy, 1810-1998', *Journal of Peace Research* **37(2)**, 251–265.

Verweij, M. (1999), 'A Watershed on the Rhine: Changing Approaches to International Environmental Cooperation', *Geo Journal* **47**, 453–461.

Verweij, M. (2000*a*), *Transboundary Environmental Problems and Cultural Theory: The Protection of the Rhine and the Great Lakes*, Palgrave, Basingstoke.

Verweij, M. (2000*b*), 'Warum der Rhein wieder rein ist', *Max Planck Forschung 3, Bonn* pp. 55–57. www.mpp-rdg.mpg.de.

Verweij, M. (2000*c*), 'Why is the River Rhine Cleaner than the Great Lakes (Despite Looser 29 Regulation)?', *Law and Society Review* **34**, 501–548.

Vlachos, E., Webb, A. & Murphy, I., eds (1986), *The Management of International River Basin Conflicts*, George Washington University, Washington, D.C. Proceedings of a Workshop, Laxenburg, Austria, September 22—25.

Vogel, D. (1997), 'Trading Up and Governing Across: Transnational Governance and Environmental Protection', *Journal of European Public Policy* **4 (4)**, 556–571.

von Stein, J. (2008), 'The International Law and Politics of Climate Change', *Journal of Conflict Resolution* **52 (2)**, 243–268.

Wagner, U. J. (2008), 'Estimating Strategic Complementarities in a Dynamic Game of Timing: The Case of the Montreal Protocol', *Working Paper, Columbia University* .

Ward, H. (1996), 'Game Theory and the Politics of Global Warming: the State of Play and Beyond', *Political Studies* **XLIV**, 850–871.

Ward, H. (2006), 'International Linkages and Environmental Sustainability: The Effectiveness of the Regime Network', *Journal of Peace Research* **43 (2)**, 149–166.

Ward, H. (2008), 'Liberal Democracy and Sustainability', *Environmental Politics* **17 (3)**, 386–409.

Warner, J. & van Buuren, A. (2009), 'Multi-Stakeholder Learning and Fighting on the River Scheldt', *International Negotiation* **14 (2)**, 419–414.

Waterbury, J. (1997), 'Between Unilateralism and Comprehensive Accords: Modest Steps toward Cooperation in International River Basins', *Water Resources Development* **13**, 279–289.

Windmeijer, F. (2002), 'ExpEnd, a Gauss Programme for Non-Linear GMM Estimation of Exponential Models with Endogenous Regressors for Cross Section and Panel Data', *cemmap working paper* **CWP14/02**.

Windmeijer, F. (2008), GMM for Panel Count Data Models, *in* L. Mátyás & P. Sevestre, eds, 'The Econometrics of Panel Data', Springer-Verlag, Berlin Heidelberg, pp. 603 – 624.

Wolf, A. (1995), *Hydropolitics along the Jordan River: The Impact of Scarce Water Resources on the Arab-Israeli Conflict*, United Nations University Press, Tokyo and New York.

Wolf, A. (1997), 'International Water Conflict Resolution: Lessons from Comparative Analysis', *Water Resources Development* **13**, 333–365.

Wolf, A., ed. (2006–2008), *Hydropolitical Vulnerability and Resilience along International Waters (5 vols.: Africa, Latin America, North America, Asia, Europe)*, UN Environment Programme, Nairobi.

Wolf, A., Kramer, A., Carius, A. & Dabelko, G. (2005), Managing Water Conflict and Cooperation, *in* W. Institute, ed., 'State of the World 2005: Redefining Global Security', W. W. Norton, Washington, D.C., pp. 80–95.

Wolf, A. T. (1998), 'Conflict and Cooperation along International Waterways', *Water Policy* **1 (2)**, 251–265.

Wolf, A. T., Stahl, K. & Macomber, M. F. (2003), 'Conflict and Cooperation within International River Basins: The Importance of Institutional Capacity', *Water Resources Update* **125**, 1–10.

Wolf, A. T., Yoffe, S. B. & Giordano, M. (2003), 'International Waters: Identifying Basins at Risk', *Water Policy* **5 (1)**, 29–60.

Wooldridge, J. M. (1997), Quasi-Likelihood Methods for Count Data, *in* M. H. Pesaran & P. Schidt, eds, 'Handbook of Applied Econometrics', Blackwell, Oxford, pp. 352–406.

World Bank (1993), *Water Resources Management*, World Bank, Washington, D.C.

Wüst, B. (2006), 'State of the Art der computergestützten Inhaltsanalyse', *unpublished manuscript* .

Yoffe, S., Fiske, G., Giordano, M., Larson, K., Stahl, K. & Wolf, A. T. (2004), 'Geography of International Water Conflict and Cooperation: Data Sets and Applications', *Water Resources Research* **40**, 1–12.

Yoffe, S. & Larson, K. (2002), Basins at Risk: Water Event Database Methodology, *in* S. Yoffe, ed., 'Basins At Risk: Conflict and Cooperation Over International Freshwater Resources', Ph.D. Dissertation, Department of Geosciences, Oregon State University.

Yoffe, S., Wolf, A. & Giordano, M. (2003), 'Conflict and Cooperation over International Freshwater Resources: Indicators of Basins at Risk', *Journal of the American Water Resources Association* **39(5)**, 1109–1125.

Young, O. (1994), *International Governance: Protecting the Environment in a Stateless Society*, Cornell University Press, Ithaca, NY.

Young, O. (1999), *The Effectiveness of International Environmental Regimes: Causal Connections and Behavioral Mechanisms (Global Environmental Accord: Strategies for Sustainability and Institutional Innovation)*, MIT Press, Cambridge, MA.

Zawahri, N. A. (2009), 'Third Party Mediation of International River Disputes: Lessons from the Indus River', *International Negotiation* **14 (2)**, 281–310.

Zawahri, N. A. & Gerlak, A. K. (2009), 'Navigating International River Disputes to Avert Conflict', *International Negotiation* **14 (2)**, 211–227.

Zawahri, N. A. & Mitchell, S. M. (2008), 'Fragmented Governance of International Rivers: Negotiating Bilateral versus Multilateral Treaties'. Paper prepared for presentation at the 2009 annual meeting of the International Studies Association, February 15-18, New York, NY.

Zeng, K. & Eastin, J. (2007), 'International Economic Integration and Environmental Protection: The Case of China', *International Studies Quarterly* **51(4)**, 971–995.

Zilbauer, M. (2005), 'Determinants of International Environmental Cooperation. Does National ENGO Strength Foster a Country's International Environmental Commitment?', *Unpublished manuscript, University of Konstanz, Konstanz, Germany* . `http://www.ub.uni-konstanz.de/kops/volltexte/2005/1667/`, consulted October 5th 2006.

Zinnes, D. A. (2004), 'Constructing Political Logic: The Democratic Peace Puzzle', *Journal of Conflict Resolution* **48(3)**, 430–454.

bar

6	**alliance** ratification of freshwater treaty
5	**official support** signing of freshwater treaty
4	**agreement/commitment** closing plant in own country that possibly leads to pollution in other country offering voluntary commitment, such as water supply financial support for water projects in other country, such as creation of sewage treatment facility any legally binding, cooperative actions that are not treaties cooperative/joint water management (irrigation, water supply, etc.) projects
3	**agreement of low scale** visit by head of state with discussion joint water issues meeting of environmental ministers/heads of states for talks on joint water issues drafting cooperation agreement/joint policy agreement to set up cooperative working groups setting up expert group/commission (on joint water issues)
2	**verbal support** official support of policy meeting of river commission with expression of policy goals minor reaction to environmental accidents, such as establishment of an information hotline invite inspectors from other country in order to dispel doubts on possible pollution, etc. proposing compromise/solution to a dispute expressing willingness to come to an agreement
1	**minor official exchanges, talks or policy expressions** meeting of high officials discussing joint water issues

	visit by lower officials for talks on joint water issues proposing talks on joint water issues submitting position on joint water problem demanding action from other country(code -1 if with negative connotation); calling for international assistance after a flood, etc. is to be coded positively, i.e. bar=1 informing other country about environmental accidents
0	**neutral acts** rethorical statements interaction by private actors (no involvement of government, officials, etc.)
-1	**mild verbal expressions displaying discord in interaction:** proposing unwanted dam or other flow regulation demanding action from other country (code +1 if with positive connotation; calling for international assistance after a flood, etc. is to be coded positively, i.e. bar=1) delaying talks/refuse to take part in talks refusing to accept compromise/ solution to dispute proposed by other country failure to come to reach agreement in dispute settlemen attempt
-2	**strong verbal expressions displaying hostility in interaction:** failure to report environmental accidents harmful to other country (e.g. oil leaking off sunken ship) turning to court making threatening demands and accusations (only if by officials) postponing heads of state visits refusing participation in meetings/summits expectation that country will do any of the actions described in bar -3 or lower (in these cases use "expectation of" and then add the expected action as described in bar -3, etc. for descr, i.e. descr could be "expectation of closing a dam's flood gates causing harmful consequences for other country"

-3	**hostile actions:** disposal of waste in shared water contamination of shared water abrogation of a water agreement opening/closing a dam's flood gates causing harmful consequences for other country
-4	breaking diplomatic relations intentious pollution unilateral construction of water projects against another country’s protest reducing flow of water to another country
-5	any violent acts (that do not yet constitute a war)
-6	Violent conflict, formal declaration of war