Ozone, Iteration, and International Law

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I. INTRODUCTION

The set of treaties governing the production and consumption of ozone-depleting substances is generally considered to have been an extremely successful response to a problem of great scientific and political complexity.\(^1\) Although stratospheric diffusion

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1. See, e.g., Edward A. Parson, Protecting the Ozone Layer, in INSTITUTIONS FOR THE EARTH 27 (Peter M. Haas et al. eds., 1993) ("The ozone treaty is widely cited as the most successful example of international environmental cooperation to date and the best model for progress on such issues as climate change."); EDITH BROWN WEISS ET AL., INTERNATIONAL ENVIRONMENTAL LAW AND POLICY 663 (1998) ("The Montreal Protocol is a pathbreaking example of countries' willingness to address a problem in which the harmful consequences of our activities today will be felt primarily by our children and their descendants.").

Richard Benedick opens his book on the ozone treaties with the following light-purple prose:

On September 16, 1987, a treaty was signed that was unique in the annals of international diplomacy. Knowledgeable observers had long believed that this particular agreement would be impossible to achieve because the issues were so complex and arcane and the initial positions of the negotiating parties so widely divergent. Those present at the signing shared a sense that this was not just the conclusion of another important negotiation, but rather a historic occasion. It was hailed as "the most significant international environmental agreement in history," "a monumental achievement," and "unparalleled as a global effort."

RICHARD ELLIOT BENEDICK, OZONE DIPLOMACY 1 (enlarged ed. 1998). Given that Benedick led the US negotiating team for the Protocol, one might view the passage as unreliably laudatory were his views not so frequently echoed by others. Compare, for example, passages from a freshly minted textbook on international environmental law:

The [global-commons] problems posed by ozone depletion were unlike anything international environmental law had ever addressed.... Moreover, during the initial negotiations and ratification, there was genuine doubt about whether ozone depletion had even occurred.... Thus
ensures that the benefits of a thicker ozone layer will be a pure public good, and although anthropogenic ozone-depleting substances have long played a variety of important and low-cost roles in developed economies, dozens of developed nations have agreed to dramatic reductions in the use of such substances and well over one hundred developing nations have agreed to a more lenient schedule of reductions. In addition, in an unprecedented example of North-South redistribution, the developed nations as a group have agreed to pay 100% of the compliance costs incurred by their poorer counterparts.

Furthermore, the implementation of the relevant treaties has been nearly as successful as the formulation of the rules themselves. First, the formal assent of nations to the obligations of the treaties has been widespread, especially among the developed nations that currently produce the lion’s share of the regulated substances. Second, disputes over interpretation of the treaties have been essentially non-existent. Third, and perhaps most importantly, compliance with both the letter and the spirit of the treaties appears to have been high. In terms of both promise and performance, therefore, the treaties on ozone-depleting substances appear to be a successful example of international cooperation.

the Protocol was ... the first 'precautionary treaty,' instituting tough technology-forcing controls as a safeguard against uncertain future harms. DAVID HUNTER ET AL., INTERNATIONAL ENVIRONMENTAL LAW AND POLICY 545, 606 (1998).

While the Protocol has not proven a total success, its adoption and implementation do represent a diplomatic breakthrough. In no other treaty have so many disparate actors in international society successfully cooperated and compromised to address a global environmental threat. Id.

2. For an extended summary of the science, politics, and law of the ozone treaties see VED P. NANDA, INTERNATIONAL ENVIRONMENTAL LAW AND POLICY 209-33 (1995). See also id. at 233-36 (appraising treaty favorably, setting forth areas of particular strength, and noting some remaining weaknesses).


4. See discussion infra Part II.D. See generally Owen Greene, The System for Implementation Review in the Ozone Regime, in THE IMPLEMENTATION AND EFFECTIVENESS OF INTERNATIONAL ENVIRONMENTAL COMMITMENTS: THEORY AND PRACTICE 89 (David G. Victor et al. eds., 1998) [hereinafter INTERNATIONAL ENVIRONMENTAL COMMITMENTS] (examining a wide variety of mechanisms for compliance available within legal and institutional context of ozone treaties); David G. Victor, The Operation and Effectiveness of the Montreal Protocol’s Non-Compliance Review, in INTERNATIONAL ENVIRONMENTAL COMMITMENTS, supra (focusing on non-compliance mechanism specified, in general terms, by ozone-treaty provisions). On the fact that developing nations are (or at least were initially) the primary producers of ozone-depleting substances, see infra note 6.
Analysts offer a variety of explanations for the success of these treaties. Some argue that an early U.S. statutory ban on certain ozone-depleting substances in the U.S. marketplace pushed U.S. businesses to seek a global ban as a way to prevent foreign producers of ozone-depleting substances from gaining a competitive advantage. In this view, the U.S. chemical companies and the resulting pressure they placed on the U.S. government were responsible for allowing or compelling the U.S. government to push (successfully) for global reductions.\(^5\) Those who adopt a collective-action perspective might emphasize that, in an important sense, relatively few actors were truly relevant: only a handful of companies in a handful of countries produced ozone-depleting substances when international negotiations on the topic began.\(^6\) Those who emphasize the difficulties of redistributing wealth through bargaining might note that these companies were able to develop relatively low-cost alternatives as the international legal regulation of ozone unfolded.\(^7\) Still other analysts emphasize

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5. Enders and Porges write:
For many years, the industry resisted any form of regulation of CFCs. Unilateral governmental regulation of CFCs in one entity led to the capture of market share by producers of another entity—as the domestic industry argued after the United States' aerosol ban in 1978. Once regulation was inevitable by the mid-1980s, only coordinated regulatory actions taken simultaneously by the governments where major consuming markets are located was acceptable to producers.

Alice Enders & Amelia Porges, Successful Conventions and Conventional Success: Saving the Ozone Layer, in THE GREENING OF WORLD TRADE ISSUES 137 (K. Anderson & R. Blackhurst eds., 1992); cf. Peter M. Morrisey, The Evolution of Policy Responses to Stratospheric Ozone Depletion, 29 NAT. RESOURCES J. 793, 815 (1989) (stating that U.S. industry "waged a long, hard battle against the regulation of CFCs" in the 1970s, but softened opposition by mid-1980s owing to "increasing worldwide demand for CFCs, coupled with the growing scientific evidence on the role of CFCs as both an ozone depleter and a greenhouse gas, and the realization that some type of international agreement... would be adopted").

6. See, e.g., Enders & Porges, supra note 5, at 136-37 ("The two leading world consumers of CFCs, the United States and the EC, each accounted for about 30 per cent of world production of CFCs. [Respectively these numbers were 30 and 45 per cent...."); Parson, supra note 1, at 29 ("CFC production is concentrated in a few countries. [For example, in the 1970s, the United States produced about half the world total, and DuPont about half the U.S. total."); David Hunter et al., supra note 1, at 550 ("The manufacture of CFCs and other ODSs [Ozone Depleting Substances] have always been concentrated in just a few multinational corporations."); see also id. at 551 (showing three producers accounting for 87% of U.S. CFC production in 1989).

7. See, e.g., Detlef Sprinz & Tapani Vahtoranta, The Interest-based Explanation of International Environmental Policy, 48 INT'L ORG. 77, 93 (1994) (stating that "success of [U.S. and German] industries in substituting new compounds for CFCs" appears "to have played a major role in persuading the FRG and the United States to accept deep cuts in
the role of an "epistemic community"—a transnational collection of scientists and policy-makers who, in the case of ozone, rapidly came to share a common perception of the causes of and a proper solution to the problem. For yet another school of thought, a straightforward calculation of benefits and risks is a sufficient explanation (at least in providing an account for the differential enthusiasm for the endeavor among different nations).

One might even explain the outcome of the ozone treaties in terms of the balance of politically prominent synecdoches. Spray cans, which came to stand for the production of ozone-depleting substances, often propel relatively frivolous products into the air; skin cancer, which came to stand for the effects of ozone depletion,

the production and consumption of CFCs); see also Thomas Bernauer, The Effect of International Environmental Institutions: How We Might Learn More, 49 INT’L ORG. 351, 373 (1995) (examining interaction between strength of regulations on ozone-depleting substances and availability of substitutes); cf. ABRAM CHAYES & ANTONIA HANDLER CHAYES, THE NEW SOVEREIGNTY: COMPLIANCE WITH INTERNATIONAL REGULATORY AGREEMENTS 143 (1995) ("At the time the [Montreal] Protocol was written, in 1987, only five large chemical companies operating in a small number of countries produced CFCs... [T]he same companies also controlled the likely substitutes and, in a number of countries, the alternative to an effective international regime was unilateral domestic prohibition.").

8. The seminal work using this particular verbiage is a case study by Peter Haas of international environmental cooperation. PETER M. HAAS, SAVING THE MEDITERRANEAN: THE POLITICS OF INTERNATIONAL ENVIRONMENTAL PROTECTION (1990). For a slightly later and more generally applied formulation of the concept, see Peter M. Haas, Introduction: Epistemic Communities and International Policy Coordination, 46 INT’L ORG. 1, 3 (1992) ("An epistemic community is a network of professionals with recognized expertise and competence in a particular domain and an authoritative claim to policy-relevant knowledge within that domain or issue-area."). The lay person may wish, as a first approximation, to think of epistemic communities as "scientists and those who believe them," but Haas clearly offers a broader definition. See id. at 3 n.4 ("[W]e stress that epistemic communities made up of natural scientists or professionals need not apply the same methodology that natural scientists do."). Haas has applied the epistemic-community perspective to international regulation of ozone-depleting substances. Peter M. Haas, Banning Chlorofluorocarbons: Epistemic Community Efforts to Protect Stratospheric Ozone, 46 INT’L ORG 187 (1992). But see KAREN T. LIFTIN, OZONE DISCOURSES 5-7 (1994) (rejecting view of ozone regime as growing out of epistemic community in favor of multi-causal “discursive practices” model). See generally 46 INT’L ORG 1992 (special issue presenting epistemic-community analysis by a variety of authors of a variety of international issues, including whaling, the Uruguay round of trade negotiations, nuclear arms control, and food aid).

9. See Sprinz & Vahtoranta, supra note 7, at 93 ("The aim of this article is to present a parsimonious explanation by concentrating on two unit-level factors of major importance, namely, a country's ecological vulnerability toward pollution and the economic costs of pollution abatement."). An illustration of this methodology is the authors' correlation of differential rates of skin cancer in various developed nations with those countries' enthusiasms for the regulation of ozone-depleting substances. See id. at 86-93.
carries with it the much graver implications of malignancy and mortality.\textsuperscript{10} Or perhaps there is not really much metaphorical balancing to be done at all: the idea that invisible substances will rise into the atmosphere and create a “hole” in the sky, through which invisible radiation will pass to harm us, might stir irrational fears at once both primeval and post-nuclear. (Although these descriptions emphasize single causes, there are of course many who make multi-causal arguments\textsuperscript{11}—and still others who question, or at least reserve judgment upon, whether the ozone treaties are a noteworthy success at all.\textsuperscript{12} This article explores an alternative explanation, which I call the “iterative perspective,”\textsuperscript{13}

\begin{itemize}
\item 11. See Morrisette, supra note 10, at 812-16 (arguing that international consensus for substantive regulation of ozone-depleting substances stemmed from combination of evolving scientific understanding of problem, catastrophic nature of skin-cancer risks and ozone hole, and industry belief that substitutes would be available if international agreement provided proper incentives); Parson, supra note 1, at 27 (“Some argue . . . that ozone was an easy issue—that strong scientific evidence, the lack of coherent industry opposition, and the availability of alternatives meant that CFCs would have been eliminated with or without effective international institutions.”); see also Thomas Bernauer, The Effect of International Environmental Institutions: How We Might Learn More, 49 INT’L ORG. 351, 373 (1995) (“The ozone example suggests that measurements of institutional effect will rarely be clear cut and totally reliable, because behavior and environmental outcomes are often due to multiple causes and we cannot control history as we do laboratory events.”) (emphasis added); cf. Benedick, supra note 1, at 313-20 (offering twelve lessons from ozone treaties, such as “Scientists must play a central role in international environmental regulations,” with each lesson at least impliedly a causal contributor).
\item 12. See G. TYLER MILLER, LIVING IN THE ENVIRONMENT 302 (7th ed. 1992) (“Most scientists agree that the treaty is an important symbol of global cooperation but that it does not go far enough in preventing significant depletion of the ozone layer and global warming.”); Parson, supra note 1, at 72 (“The risk remains open that even the seemingly rapid international progress achieved will be insufficient to avert serious global ozone loss.”); HUNTER et al., supra note 1, at 576 (“While the nearly universal ratification of the Protocol must be regarded as a triumph of international diplomacy, implementation of the Protocol still faces significant obstacles [from extension requests from Russia and East European countries, from other countries’ problems with methyl bromide and HCFC schedules, and from developing countries.”)."
\item 14. Institutionals were originally known as expositors of “regime theory,” and are sometimes known now as “Neo-Liberal Institutionals” or “Liberal Institutionals.” For a recent discussion of Institutionaism by the leading exponent of the theory, see Robert O. Keohane, International Institutions: Can Interdependence Work?, 110 FOREIGN POL’Y 82 (1998). See also John K. Setear, Responses to Breach of a Treaty and Rationalist International Relations Theory: The Rules of Release and Remediation in the Law of
\end{itemize}
for the success of the ozone treaties. Derived from the work of theorists of international relations (IR) whom I shall call "Institutionalists," the iterative perspective adopts the assumption of Institutionalists that one may analogize many areas of IR to the Iterated Prisoner's Dilemma (IPD). The IPD is a

_Treaties and the Law of State Responsibility_, 83 VA. L. REV. 1, 3 n.3 (1997) (collecting descriptions by legal scholars of Institutionalism) [hereinafter Setear, _Responses to Breach_].

IR theorists have produced a stream of writings with at least four main branches, among which Institutionalism is not necessarily the main channel.

IR Realists view international affairs as a constant, anxious struggle among essentially rational nations for relative gains, with an emphasis on security issues. For a relatively recent discussion of Realism by perhaps its most academically prominent exponent, see John J. Mearsheimer, _The False Promise of International Institutions_, 19 INT'L. SECURITY 5, 9-14. _See also id._ at 15-26 (describing and criticizing Institutionalism and Constructivism).

IR Institutionalists adopt many of the assumptions of IR Realists but emphasize the possibility that nations will nonetheless use institutions to amplify the possibilities for cooperation, especially with respect to non-security issues. _See Setear, Responses to Breach, supra_ note 14, at 2 n.2, 3-4 nn. 4-5, 9 n.9 (comparing Institutionalism with Realism).

IR Liberals, in contrast both to Realists and Institutionalists, emphasize what one might call domestic politics, including not only the form of government generally but also the interactions across national boundaries of sub-national groups. _See id._ at 6 n.8 (discussing classical Liberalism and Neo-Liberalism in IR, though omitting reference to trans-national cooperation of sub-national groups); Anne-Marie Slaughter Burley, _International Law and International Relations Theory: A Dual Agenda_, 87 AM. J. INT'L L. 205, 226-31 (1993) (describing Liberal theory and suggesting various applications to international legal questions).

IR Constructivists, a relatively new current in the IR literature, would be familiar to legal scholars as cousins to the Critical Legal Studies movement, although Constructivists place comparatively less emphasis on hierarchy and rules, and comparatively more emphasis on how actors construct their view of the world and their interests. _See generally_ Setear, _Responses to Breach, supra_ note 14, (briefly describing Constructivists); Mearsheimer, _supra_, at 9-14 (discussing Constructivism from perspective of a Realist).

15. _See ROBERT O. KEOHANE, AFTER HEGEMONY: COOPERATION AND DISCORD IN THE WORLD POLITICAL ECONOMY_ 74-78 (1984) (discussion by leading Institutionalist of Prisoner's Dilemma in international relations); Mearsheimer, _supra_ note 14, at 17 (statement by a leading Realist that "the famous 'Prisoner's Dilemma'... is the analytical centerpiece of most of the liberal institutionalist literature"); _see also_ Setear, _Iterative Perspective, supra_ note 13, at 190 (adopting, as an assumption of "iterative perspective," view that Institutionalism and its use of the IPD are a useful starting point in analysis of law of treaties); John K. Setear, _Law in the Service of Politics: Moving Neo-Liberal Institutionalism from Metaphor to Theory by Using the International Treaty Process to Define "Iteration,"_ 37 VA. J. INT'L L. 641, 643 (1997) (focusing on iteration, both as a concept to which Institutionalists have paid insufficient attention generally and as a feature of international treaty process suitable for further study by Institutionalists) [hereinafter cited as Setear, _Law in the Service_]; _cf._ Setear, _Responses to Breach, supra_ note 14, at 27-63 (blending use of IPD and transactions-cost analysis to evaluate rules of law of treaties governing material breach).
“game”—a formal specification of the options (sometimes called “actions” or “strategies”) of the participants (often called “players”) and the outcomes (often called “payoffs”) that will result from a given interaction of the participants’ chosen options. The two-player Prisoner’s Dilemma is a particular game in which each player improves the status quo if the other player cooperates, but in which a player will suffer an absolute loss if that player cooperates while the other player does not. There is thus both a gain from joint cooperation and a temptation to defect from the cooperative solution. Furthermore, because the payoff structure of the Prisoner’s Dilemma gives a player a smaller payoff when that player cooperates and the other defects than when both players defect, a player always does better to defect for a given choice by the other player. Consequently, there is a strong incentive, at least when the two-player Prisoner’s Dilemma is played just once, for each player to choose to defect. If the Prisoner’s Dilemma is played repeatedly (is “iterated”), however, then each player’s ability in later rounds to punish the opponent for defections in earlier rounds opens up the possibility that a rational, stable, cooperative solution to the IPD will develop. Indeed, some computer simulations involving the IPD show remarkably simple strategies are quite successful, which presumably pleased those who hoped that the cumbersome

17. See Setear, Barrister and the Bomb, supra note 16, at 577; Setear, Iterative Perspective, supra note 13, at 177-78.
19. See id. at 178 n.158 (describing formalization of this idea in the “Nash equilibrium”).
20. See Setear, Law in the Service, supra note 15, at 657-59; cf. id. at 663-75 (discussing a variety of ways in which boundaries of iteration affect analyses using IPDs).
decision-making machinery of nation-states might be able to replicate the success of strategies that could be successfully formulated by individuals.\(^{22}\)

The iterative perspective adopts as well the conclusion of Institutionalists that cooperative solutions to collective-action problems in international relations may evolve with the assistance of international institutions.\(^{23}\) While the precise definition of an "institution" remains a matter of some ambiguity, the basic idea is that rules are relevant to international affairs, that these rules are part of institutions, and that an "institution" is a broader notion than just a headquarters and staff.\(^{24}\) By increasing the likelihood of future interactions, clarifying the substantive behavior that constitutes cooperation, and providing a particular place or set of meta-rules for resolving disputes, the existence of an institution in a given issue-area lowers transaction costs and thus increases the chances that nation-states will cooperate effectively with respect to that issue.\(^{25}\)

To many international lawyers, this talk of rules and institutions and the IPD sounds a good deal like a description of international law for anyone who can simultaneously hold in his or her mind both the notion that international law is "law" and the notion that international law is a decentralized system.\(^{26}\) In any case, there is

\(^{22}\) See Robert Axelrod & Robert O. Keohane, Achieving Cooperation Under Anarchy: Strategies and Institutions, in COOPERATION UNDER ANARCHY 226, 232 (Kenneth A. Oye ed., 1986) (citing Axelrod's Evolution of Cooperation, which used individual players, for propositions relevant to nations); id. at 247 (citing laboratory studies, presumably of individuals, as relevant to determining national actions taken by leaders).

\(^{23}\) See Setear, Iterative Perspective, supra note 13, at 184-85, 190 (discussing role of institutions in Institutionalism and describing law of treaties as an institution, respectively); Setear, Law in the Service, supra note 15, at 647 (describing role of institutions in Institutionalism).

\(^{24}\) See Setear, Law in the Service, supra note 15, at 647 (describing role of institutions in Institutionalism); Mearsheimer, supra note 14, at 18 (describing focus of Institutionalism on rules).

\(^{25}\) See, Keohane, supra note 15, at 89-90; Setear, Iterative Perspective, supra note 13, at 184-85 (discussing role of institutions in Institutionalism and describing law of treaties as an institution, respectively).

\(^{26}\) See Slaughter Burley, supra note 14, at 219-20.
certainly room for international legal analysis to make use of IR theory and for IR theorists to pay some attention to international legal rules, or at least to entities chartered by treaty, that function through the use of precise legalistic texts.27 One may move—probably must move, in fact—beyond the generalities favored by IR theorists and towards considering particular rules in particular institutional contexts. With respect to the treaty process, I have argued that such a movement can provide those who examine international cooperation with a rich source of data and, courtesy of the formalities of the law of treaties, with a well-defined set of iterations that are both descriptively and prescriptively useful in


connecting the IPD-driven theories of Institutionalism with the real world.

This article is about using IR theory, especially the iterative perspective, to explore and evaluate the use of international law, especially treaties, as a method of international cooperation concerning the ozone layer. National governments chose to address the problem of ozone depletion through international legal means, i.e. a series of treaties that I collectively call the "ozone-treaty regime" or the "ozone treaties." As a result of both the default rules implicit in choosing treaties as an instrument of international legal cooperation and the particular rules explicitly specified in the ozone treaties, the ozone-treaty regime has promoted a wide variety of repeated, formalized interactions between nations—"iterations," for short. The temporal boundaries of these iterations are clear. The mechanisms for formally signaling an intention to participate in the cooperative endeavor set forth in these treaties, as well as the substantive behavior comprising actual cooperation (as opposed to an uncooperative "defection"), are clear as well. As I have argued at greater length elsewhere, high-definition iterations like those created by the ozone treaties provide the ideal backdrop for the evolution of cooperation among parties, like nation-states in contemporary international politics, who face an IPD but lack a centralized enforcement system.

From the iterative perspective, then, the success of the ozone treaties is the result of a series of policy choices that promote temporally well-defined iterations with clear mechanisms for signaling formal consent, and with clear rules for determining actual compliance by nation-states seeking a cooperative solution to a difficult international political problem.

The iterative perspective is distinctive in three ways from the typical explanations advanced to account for the success of the ozone treaties. The iterative perspective is a dynamic explanation of international cooperation with respect to ozone-depleting substances, in that it examines interactions through time and postulates increasing cooperation over time. It is a legalistic explanation of ozone-oriented international cooperation, in that it examines the general and specifically tailored rules of international law as factors in international politics. It is a textually

oriented explanation of ozone-oriented cooperation, in that it takes seriously and examines closely the particular words set forth in the international legal enactments, which specifically address the problem of ozone depletion. In its examination of the dynamics of international cooperation, this article is much more detailed than most studies of the evolution of cooperation. In its examination of a legalistic explanation for international cooperation, this article is part of a slowly growing body of scholarship that attempts to integrate international politics and international law within a contextualized but rationalistic and rigorous framework. In its focus on the text of the ozone treaties as an explanation for their success, the article takes seriously the notion that nations might take seriously their international legal obligations—although the article does not ignore the issue of actual compliance with the rules specified in the text of the ozone treaties.

I do not claim that this iterative perspective is the only viewpoint that offers any explanatory utility with respect to the success of the ozone treaties. The views described above each contribute to the analysis. Any moncausal argument seems unlikely to be truly persuasive when examining an issue area as complex as ozone depletion.

Nor do I claim that this article’s application of the iterative perspective conclusively demonstrates a general superiority of the perspective in explaining international cooperation. I examine only one case study. It is a case study that involves both extensive iteration, on the one hand, and increasing and eventually extensive cooperation over time, on the other. The correlation is suggestive of a broader utility, and this article develops a number of tools that one might use in future efforts to examine international cooperation. Nonetheless, any advancement of general claims about the consistency of the iterative perspective with the empirics of international relations would obviously require additional case studies: perfect consistency between this theory and the practical workings of international politics would require a demonstration that all cases of minimal iterativeness lead to minimal and static (or even declining) levels of cooperation, and that all cases of extensive and increasing cooperation occur against a densely iterative background. Perfect consistency, of course, seems unlikely in the complex world of international relations, but even a casually plausible generality for the iterative perspective as an explanation for the differential success of various treaties requires
more than one case study of a particular issue in international relations.

The organization of this article is as follows. Parts One and Two focus directly on the iterative perspective, while Part Three examines the broader utility of the data that one may derive from an iterative focus. Part One examines the particular textual choices made in the first two ozone treaties, in order to evaluate the degree to which these choices promote iteration. Part One also examines the particular choices that the drafters of the first two ozone treaties made, and concludes that those choices are consistent with the concern for promoting iteration that the iterative perspective predicts as a correlate of successful efforts at international cooperation.

If one analogizes the international cooperative process to a production process, then Part One examines what one might call the “inputs.” Part Two, in contrast, examines what one might call the “outputs” of that process—the changes in the regulations on ozone-depleting substances made in subsequent versions of the treaty texts, the formal pledges of adherence made by various nations to the treaties, the actual degree of behavioral compliance with the relevant textual provisions, and so on. Part Two concludes that the facially iteration-promoting choices discussed in Part One in fact led to a series of additional iterations resulting in a series of additional international legal enactments and, more importantly, affected the actual behavior of the parties formally consenting to those rules.

Part Two also examines the detailed dynamics of the ozone treaties as they have unfolded one after another, and reaches some conclusions about the flexibility and persistence of various types of provisions. The ozone treaties reflect an early and undisturbed decision about their core regulatory approach to the consumption and production of ozone-depleting substances; a persistent effort to calibrate the proper exceptions to the strictures set forth in that core approach; a monotonic increase in both the number of chemicals within the ambit of the treaty scheme and the strictness of regulation concerning already-included chemicals; a biannual alternation between periods of major enactments and quiescence; a tentative but innovative movement towards explicitly addressing problems of non-compliance with the treaties; and a broad maturation in the system as a whole as the second decade of the
international cooperative scheme embodied in the ozone treaties commenced.

Part Three revisits the “outputs” data derived in Part Two to test some non-iterative hypotheses put forward by legal academics and political scientists interested in international legal cooperation. Using one portion of that data (the formal expressions of consent by nation-states to the rules of the ozone treaties, which I call the “coverage” of the ozone-treaty regime), I test a pair of hypotheses derived from sharply contrasting views of international legal cooperation. One hypothesis, derived from the “Liberal” view of international relations, predicts that democracies are more likely than autocracies both to join the ozone-treaty regime at all and to participate extensively therein. Another hypothesis, derived from the “Realist” view of international relations, asserts that nation-states construct international legal regimes that do not actually require them to change their behavior. As others have presented this hypothesis, it is not falsifiable. Part Three nonetheless attempts to nudge the Realist hypothesis in directions that make it susceptible to empirical proof or disproof—especially with the coverage data developed in Part Two. Part Three concludes that there is significant support for the Liberal hypothesis and support, albeit muddied, for the hypothesis derived from the Realist view of international relations—although it should be emphasized at the outset that the paper does not undertake tests of statistical significance with respect to any hypothesis.

II. THE INPUTS OF ITERATION IN THE OZONE TREATIES

In previous work, I have argued that the law of treaties—the set of general procedural rules governing the degree of obligation imposed upon nations by the text of any particular treaty—is consistent with an institutional design aimed at promoting a formally delineated series of structured interactions between parties (“iterations”), and that such an institutional design promotes the evolution of cooperative behavior against the backdrop of the Prisoner’s Dilemma typically thought to describe the incentives facing nation-states contemplating international political cooperation.29 I have also previously argued that, in addition to the generally iterative structure that the law of treaties

imposes upon the interactions of states with respect to each particular treaty instrument ("intra-instrument iteration"), the texts of some particular treaties erect a series of iterations across treaties by facilitating or even requiring the parties to participate in subsequent treaties concerned with the same subject matter ("inter-instrument iteration"). (The ozone treaties provide an example of inter-instrument iteration.)

In this article, I examine, from the iterative perspective, the particulars of the treaties governing the production and consumption of ozone-depleting substances. In this Part, I examine the degree to which the two earliest texts in the ozone-treaty regime promote iteration, especially as compared to an idealized "typical" treaty. Subsequent parts delve into the dynamics of the later texts in the ozone-treaty regime, especially their consistency with the iterative perspective, and examine data derived from this pursuit of the iterative perspective in light of non-iterative theories of international cooperation.

A. *The Iterative Perspective*

I have argued in previously published articles that a concern for promoting iteration, which one may easily derive from the theories of rationalist scholars of international relations known as "neoliberal Institutionalists," can provide international lawyers and legal academics with a fresh perspective on the rules and rationales of the area of international law known as the law of treaties.30

Codified in the Vienna Convention on the Law of Treaties,31 the law of treaties sets forth the procedural rules by which nations indicate varying degrees of consent to the rules of a treaty. The Convention also discusses the conditions under which the obligations nominally triggered by formal consent are excused as a result of such phenomena as fraud or breach by another party. Additionally, it sets forth the rules for interpreting the provisions of valid treaties.

30. See id. (focusing on when treaties are valid and on how to interpret ambiguous provisions); Setear, *Responses to Breach*, supra note 14 (focusing on responses to breach of assumedly valid and unambiguous treaties).


32. For a description of the IPD, see discussion supra pp. 198-202.
Derived from the theories of neoliberal Institutionalists, the iterative perspective adopts the assumption of Institutionalists that one may analogize many areas of international relations to the Iterated Prisoner’s Dilemma (IPD). The iterative perspective adopts as well the conclusion of Institutionalists that cooperative solutions to collective-action problems in international relations may evolve with the assistance of international institutions. The iterative perspective uncovers and elaborates upon the crucial but implicit assumptions made by Institutionalists about the iterated (repeated) nature of the IPD, including the existence of iteration at all, its potential for reasonably objective operationalization, and its implications for institutional design generally. Neoliberal Institutionalists can advance the degree of contact between their theories and international political realities by examining a particular portion of international law—the “treaty process” governed by the law of treaties and related provisions in particular treaties—as the sort of real-world source of well-defined iterations that neoliberal Institutionalists must examine lest their theories be consigned to irrelevance as vague metaphors providing no predictive purchase.

It is this last standpoint of the iterative perspective that is most relevant to the law of treaties. Viewed from an iterative perspective, a number of aspects of the law of treaties make at least as much sense as when viewed from more traditional (and more legalistic) perspectives. Additionally, a number of ambiguities in the law of treaties may be resolved by reference to the iterative perspective. Furthermore, the iterative perspective may be attractive, at least to some, because it rests upon an instrumental desire to promote international cooperation rather than upon slightly more mystical appeals to such concepts as “consent” or “legitimacy.”

33. See supra note 23.
34. See Setear, Law in the Service, supra note 15, at 654-75.
35. See id.
36. See Setear, Iterative Perspective, supra note 13, at 203-06.
37. See id. at 206-11.
B. *Iteration and the Texts of the Ozone Treaties*

The international legal rules that regulate the consumption and production of ozone-depleting substances take the form of a series of treaties.\(^{38}\)

Sub-section one of this Section provides an overview of these treaties, including a description of the core regulatory approach of the regime and the scientific underpinnings thereof. Sub-section two discusses the first two enactments in the ozone-treaty regime as an example of the much-discussed "convention-protocol" approach to problems of international legal cooperation, and briefly describes the consistency of this general approach with the iterative perspective. In an effort to address in more detail the degree to which a greater consistency with the iterative perspective might explain the unusual success of the ozone-treaty regime in effecting international cooperation, sub-section three compares a variety of particular features of the first two enactments in the ozone-treaty regime with analogous features in the typical treaty.

1. *An Overview of the Ozone-Treaty Regime*

The ozone-treaty regime is complex. It involves seven distinct enactments creating or modifying treaty texts in the regime. The same enactment not only may set forth a variety of substantive rules but also may use a variety of procedural rules to determine which nations are partly and fully bound. The core of the regime's approach to preserving the ozone layer is a complex vector of calculations that includes a factor representing the best efforts of scientists to reduce the intricacies of atmospheric chemistry to a single number for each regulated substance. A brief overview of the regime and the relevant science may therefore be helpful.

The "ozone layer" is a colloquial expression for a portion of the atmosphere several miles above the surface of the earth and relatively rich in ozone, a molecule consisting of three atoms of

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38. I argue elsewhere that the use of treaties as a source for international legal rules is more consistent with a desire to promote formalized iterations than is the use of other forms of international law, such as custom. *See* John K. Setear, *Choosing the Mode of Laws: Sources of International Law as Alternative Regimes* (Oct. 25, 1999) (unpublished manuscript, on file with the *Virginia Journal of International Law*). From the iterative perspective, such consistency serves as at least a partial explanation for the success of the ozone treaties. Nonetheless, the comparison of the iterative utility of treaties to the iterative utility of other sources of international law occurs at a high level of generality. The present article examines not treaties as a class but rather the particular features of the ozone treaties in order to explain the particular success of the ozone-treaty regime.
oxygen. Ozone reflects ultra-violet radiation emitted by the sun. Ultra-violet radiation that strikes the earth can cause skin cancer and cataracts in humans, and, of indirect concern to humans, a wide variety of potentially harmful mutations in plants and animals. Of particular concern is harm to species that are especially sensitive to ultra-violet radiation and important in the functioning of their ecosystems.

Certain substances containing atoms of chlorine or bromine serve as catalysts for chemical reactions in the atmosphere that lead to the destruction of stratospheric ozone. These ozone-depleting substances are man-made. They serve a wide variety of functions as (among other things) refrigerants, fire retardants and propellants. They are capable of being transported from the surface of the earth into the stratosphere by naturally occurring air currents. Once in the stratosphere, these molecules typically remain in the stratosphere to catalyze the destruction of ozone molecules for many years or even many decades.

In terms of international cooperation, the anthropogenic response to this anthropogenic problem has been the enactment of the series of international legal agreements that constitute the ozone-treaty regime.

The first such enactment was the Vienna Convention for the Protection of the Ozone Layer (the "Convention"), signed in 1985 and entered into force in late 1988. See Table One. The Convention set forth some vague promises of international cooperation and some concrete procedural rules to govern future enactments.

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39. Catalysts, in the chemical sense, are substances that increase the rate of a particular reaction without themselves being consumed in the reaction.

The second enactment in the ozone-treaty regime was the Montreal Protocol on Substances that Deplete the Ozone Layer ("Original Protocol" or "Montreal Protocol"), signed in 1987 and entered into force in early 1989. This treaty set forth some concrete substantive obligations based on a core regulatory approach. I refer to the combination of the Convention and the Original Protocol as the "Initial Enactments."

Each enactment subsequent to the Initial Enactments has been a revision of the Original Protocol. The Revisions have broadened and deepened the core regulatory approach of the Original Protocol, and have adopted some supplemental approaches to the core regulatory approach, in a fashion that will be described in some detail in Part Two.

The core regulatory approach of the ozone-treaty regime establishes yearly per-nation quotas for the consumption or production of ozone-depleting substances. The per-nation quotas are set, for each "group" of chemicals of similar molecular composition, as a percentage of a given nation's consumption or

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42. A set of Revisions are designated herein by the city in which the parties to the Protocol signed the relevant Revisions, e.g., the London Revisions or Copenhagen Revisions; collectively, I refer to these subsequent enactments as the Revisions.
production of that group compared to that nation's consumption or production in a baseline year.\textsuperscript{43} I refer to this percentage the as “Allowable Percentage.” The Allowable Percentage may vary from group to group and from year to year, but the Allowable Percentage for a given group in a given year is the same for every nation. The baseline year remains constant across agreements for any given group of ozone-depleting substances. By applying a factor to each chemical's consumption or production that varies proportionally with the ozone-depleting potential (“ODP”) of that chemical (as determined by the best scientific evidence), the relevant formulae in both the year of the quota and the baseline year account for the possibility that different chemicals within a group might differentially harm the ozone layer.

A numerical example may be useful. Group II of annex A of the Original Protocol consists of “halons,” which are ozone-depleting substances that may be familiar to anyone who has ever read the signs in rare-book libraries warning of asphyxiation in the event of fire. (Halon is an excellent fire-fighting agent because it smothers fire, and everything else, quite efficiently by removing all of the free oxygen from the treated environment.) Halon-1211 has an ODP of \textsuperscript{3},\textsuperscript{44} halon-1301, which is likely to lead to the demise of more than three times as many ozone molecules as halon-1211 during each molecule's time in the stratosphere, earns an ODP of \textsuperscript{10}.\textsuperscript{45} The baseline year for halons is \textsuperscript{1986}.\textsuperscript{46} Assume that, in the baseline year, a particular nation produced 10 tons of halon-1211 and 5 tons of halon-1301 (and none of the other halons). Its ODP-weighted Group II baseline-year index would then be 80. (10 tons x 3 for halon-1211 + 5 tons x 10 for halon-1301 = (10 x 3) + (5 x 10) = 30 + 50 = 80.)

Now assume that the Allowable Percentage for halons in the year 2000 is 50\%. For any nation with an ODP-weighted Group II baseline index of 80, as in the example above, the resulting permissible ODP-weighted Group II index in the year 2000 would then be 40. (50\% x 80 = 40.)

Because of the aggregation of chemicals within a group and because of the use of the ODPs, a nation can satisfy its obligations in a given year in a variety of ways. Assume as before, a baseline

\textsuperscript{43} See Montreal Protocol, supra note 41 art. 2, at 31-33.
\textsuperscript{44} See id. Annex A, at 40.
\textsuperscript{45} See id.
\textsuperscript{46} See id.art 2(2), at 31.
index of 80 and a permissible index of 40 in a given year. One scheme that would exactly satisfy a nation’s treaty obligations is a reduction of 50% in the production of both chemicals. Such a scheme in fact yields an index of 40 in the year 2000 (5 tons x 3 for halon-1211 + 2.5 tons x 10 for halon-1301 = (5 x 3) + (2.5 x 10) = 15 + 25 = 40.)

Another permissible scheme for the year 2000 would be to continue production of halon-1211 at the level produced in the baseline year, but to reduce dramatically the production of halon-1301. Suppose, for example, that the production of halon-1211 continued at 10 tons in 2000, while the nation reduces halon-1301 production by 80%, to just one ton. Under this scheme, this nation’s halon production would also yield an index of 40. (10 tons x 3 for halon-1211 + 1 ton x 10 for halon-1301 = (10 x 3) + (1 x 10) = 30 + 10 = 40.)

2. The Convention-Protocol Approach and the Ozone-Treaty Regime

Scholars of international law have noted the development in the late-twentieth century of what one might call a “meta-treaty”: the “convention-protocol” approach to a particular subject matter of international cooperation. The convention-protocol approach involves at least two separate enactments, one “convention” and one or more “protocols.” The convention sets forth vague substantive provisions that serve mainly to acknowledge that the subject of the treaty is a matter worthy of serious further consideration. The convention includes procedural provisions that, in contrast to its substantive terms, are quite specific. The convention contemplates that one or more subsequent protocols will be created and administered largely under the procedures set forth in the convention. The protocols provide the substantive detail of the treaty regime.

The Convention on Long-Range Transboundary Air Pollution (LRTAP Convention) is an example of the convention-protocol approach, and it has led to the creation under its procedural provisions of numerous detailed protocols.

47. See, e.g., Setear, An Iterative Perspective, supra note 13, at 217-23.
concentrates on a particular category of pollutant, such as sulfur oxides or volatile organic compounds.) The Framework Convention on Climate Change has so far led to the creation of only one subsequent text, the Kyoto Protocol. Although that protocol faces significant obstacles to its ratification in the United States, it does set concrete targets for reductions in greenhouse-gas emissions by developed countries and does include a market-mimicking scheme related to carbon emissions.

From an iterative perspective, the convention-protocol approach is sensible. Full and formal consent to a convention serves as a nation-state’s cooperative response to an initial formalized interaction regarding a particular subject matter. The convention at least contemplates future iterations. Accordingly, it sets forth the procedural rules to be used in determining the substantive standards against which cooperation will be measured in future iterations, if any. To some extent, enthusiasm for the convention-protocol approach depends upon phenomena (such as the acquisition over time of scientific knowledge) that straightforward descriptions of the iterated Prisoner’s Dilemma do not incorporate. Nonetheless, the general flavor of the convention-protocol approach contains more than a dash of the iterative perspective.

Proponents of the iterative perspective, however, would do well to note that a convention typically contains no more than a


49. See S. Res. 98, 105th Cong., 1st Sess. (1997) (resolving that the United States should not agree to a protocol that would mandate new commitments to reduce greenhouse gas emissions for developed countries unless the agreement “also mandates new specific scheduled commitments to limit or reduce greenhouse gas emissions for Developing Country Parties within the same compliance period”).


contingent specification of future iterations even as a matter of international law. A convention sets forth rules that will govern future protocols if the parties agree upon such protocols; a convention does not typically involve a promise that such interactions will occur. Nonetheless, from an iterative perspective, the convention-protocol approach is, as Maurice Chevalier said about old age, better than the alternative.\footnote{See Collins Thematic Dictionary of Quotations (1992) ("I prefer old age to the alternative.").} In the international legal context, of course, the alternative is not death but rather the traditional treaty, which does not explicitly even contemplate the future construction of separate and more detailed agreements.

The Convention and the Original Protocol, true to their names, together embody a convention-protocol approach to ozone depletion. The Convention’s chief substantive requirement is appropriately, perhaps even excessively, cautious about imposing particular duties upon its adherents: the parties pledge that, “in accordance with the means at their disposal and their capabilities,” they will “[a]dopt appropriate legislative or administrative measures [to] reduce or prevent human activities . . . should it be found that these activities have or are likely to have adverse effects resulting from modification or likely modification of the ozone layer.”\footnote{Vienna Convention, supra note 40, art. 2, at 326.} The Convention also includes some promises of similar generality regarding scientific cooperation among the parties.\footnote{Id. art. 4, at 327.}

The drafters of the Convention expressly recognized the possibility of future protocols: Article 8 notes that the parties may “adopt protocols pursuant to” the above-described general provisions.\footnote{Id. art. 8, at 329.} Consistent with the formative role of a convention, the Convention also sets forth a variety of concrete procedural rules—applicable to both itself and future protocols—that govern dispute resolution,\footnote{Id. art. 11, at 331.} amendments,\footnote{Id. art. 9, at 329-30.} voting rights,\footnote{Id. art. 15, at 332.} and purely administrative aspects of the treaty such as the provision of notice for future meetings\footnote{Id. art. 6(2), at 327.} and the specification of a depositary for ratifications.\footnote{Id. art. 20, at 333.}
I have already provided an extended example of the operation of the Original Protocol’s core regulatory approach, with its baselines, ODPs, groups of ozone-depleting substances, and Allowed Percentages.\textsuperscript{61} That example should suffice to demonstrate the degree of concreteness of the Original Protocol’s regulatory scheme in stark contrast to the vagaries of the Convention.

As a general matter, therefore, the substantive platitudes and procedural precision of the Convention, paired with the well-specified substantive regulation of the Original Protocol, are consistent with the convention-protocol approach and, thereby, also consistent with a generally iterative approach to international cooperation effectuated through a series of treaties.

I turn now to a closer analysis of a variety of features in the Convention and Original Protocol in order to compare those particulars with the typical treaty and with an idealized and maximally iterative type of international treaty.\textsuperscript{62} Although the ozone treaties prove to be less than maximally iterative, they are generally more encouraging of iteration than the typical treaty.

3. \textit{Specifically Iterative Features of the Initial Enactments}

a. Meetings

Perhaps the most straightforward method of encouraging formalized interactions between the parties is simply to state that such interactions shall occur. Like the typical treaty, the Convention includes provisions of this sort. Article 6 of the Convention describes the “Conference of the Parties.” The Conference of the Parties (“CoP”) is a body of general purpose, charged with an ongoing responsibility to gather scientific information on the ozone layer and to adopt necessary textual

\textsuperscript{61} \textit{See supra} text accompanying notes 46-49.

\textsuperscript{62} An actual census of treaties, even one limited to those signed in the latter portion of the twentieth century, would involve literally thousands of separate agreements. The discussion of “typical” treaties below tends to focus on environmental treaties, with less attention to arms-control agreements and general treaties (such as the UN Charter), and with the least attention devoted to trade-oriented treaties. The focus on environmental treaties makes some obvious sense in a discussion centered on the treaties about ozone-depleting substances, while arms-control agreements are similarly technical (and relatively recent) endeavors. The short-shrifting of trade treaties in comparison to general treaties is largely the result of the author’s limited knowledge.
changes to the Convention.63 (As is common with treaties, an additional body known as the “Secretariat” also performs certain administrative functions.64) In pursuit of these general purposes, the CoP must meet initially within one year of the treaty’s entry into force, and meet subsequently thereafter “at regular intervals.”65

Such provisions appear in almost every treaty. The typical treaty thereby encourages some degree of iteration, with a specification of the relevant interval that should be easy to determine in retrospect though not necessarily in prospect. A few treaties explicitly specify the length of the regular intervals, which typically is one or two years.66 Such a provision would seem to encourage iteration more thoroughly, or at least more precisely, than the convention’s specification of the meeting interval as simply “regular.”

A treaty may delineate not only the intervals at which parties are to meet but also the subject matter about which the parties are to discuss. The specification of topics for subsequent iterations presumably encourages cooperation. Some specificity regarding future discussions shows that the parties as a group are sufficiently invested in the future of the enterprise at least to formulate the broad swath of its future course, whereas a completely general and open-ended treatment of future iterations might be taken as a lack of true commitment to future interactions between the parties. On the other end of the spectrum the immediate, irreversible and exhaustive specifications of future topics seems inconsistent with a convention-protocol approach, particularly in an area of technological and scientific uncertainty. After all, if the parties could be so precise so immediately with the specification of topics for future meetings, they presumably could also dispense with the convention stage and proceed directly to the precise specification of the relevant substantive rules.

Consistent with its general vagueness, the Convention reflects virtually no specification of topics for future meetings. Its only

63. See Vienna Convention, supra note 40, art. 6, at 327-28.
64. See id. art. 7, at 329.
65. See id. art. 6(1), at 327.
66. For example, the Treaty Concerning the Reciprocal Encouragement and Protection of Investments, Sept. 29, 1982, U.S.-Egypt, art. VI(2), 21 I.L.M. 927, states that meetings between parties are to occur once every two years. The Convention on International Civil Aviation, Dec. 7, 1944, art. 48(a), 61 Stat. 1180, 15 U.N.T.S. 295, 328, states that meetings among parties are to occur annually.
specification, which reflects the Convention's generally greater concern with procedural versus substantive rulemaking, is that the first CoP shall determine the procedures governing the arbitration option in the dispute-resolution mechanism ("DRM"). The Convention also expressly delegates to the CoP, though not to any particular meeting thereof, the designation of the forms and intervals in which and at which, respectively, a party is to transmit to the Secretariat information concerning the party's efforts to implement the provisions of the Initial Enactments.

The Original Protocol designates each of its meetings as a Meeting of the Parties ("MoP") and assigns a greater number of particular functions for the first MoP after the Original Protocol's entry into force than does the Convention's specification of the topics for the CoPs. The first MoP is obliged to "consider and approve procedures and institutional mechanisms for determining non-compliance with the ... Protocol and for treatment of Parties found to be in non-compliance." At that first MoP, the parties are to adopt rules governing its meeting procedures, to make rules relating to the finances necessary to administer the Original Protocol, to establish panels in connection with the assessment of the control measures, and to begin preparation of work-plans relating to technical assistance.

The Original Protocol also establishes a number of specific future obligations relating to meetings that must occur after a particular lapse of time.

As enacted, the Original Protocol requires parties eventually to "ban the import of controlled substances from any State not party to this Protocol." Articles 4(3) and 4(4) contemplate expansions of this ban to be effectuated by additional specified MoPs. Article 4(3) of the Original Protocol requires a MoP within three years of the Original Protocol's entry into force to produce a list of banned products incorporating the substances controlled by the Original Protocol. Article 4(4) of the Original Protocol requires

67. Vienna Convention, supra note 40, art. 6, 327-28.
68. Id.
69. See Montreal Protocol, supra note 41, art. 11, 36-37.
70. Id. art. 8, at 35.
71. Id. art. 11, at 36-37.
72. Id. art. 11(4), at 36-37.
73. Id. art. 4(1), at 33.
74. Id. arts. 4(3), 4(4), at 34.
75. Id., art. 4(3), at 34.
a MoP within five years of the Original Protocol’s entry into force to produce—if feasible—a list of banned products produced with, but not actually containing, the substances controlled by the Original Protocol.76 Taken together, these provisions imply two additional mandatory MoPs, each focused on its particular extension of the ban on the pure forms of the controlled substances set forth in the Original Protocol.77

A broader but only partly specified subject matter for future MoPs is set forth in article 6 of the Original Protocol. Article 6 requires periodic meetings at a specified regular interval—four years—for the rather comprehensive purpose of “assess[ing] the control measures provided for in Article 2 on the basis of available scientific, environmental, technical and economic information.”78 Since Article 2 is clearly the heart of the Original Protocol, this mandate is tantamount to requiring the MoP to reconsider the effectiveness of the Original Protocol at four-year intervals.

The Original Protocol also requires each party to submit a biannual summary of its activities relating to ozone research, development, public awareness, and exchanges of information, but there is no requirement that the parties meet to discuss these activities.79 Similarly, if a bit more stringently, the Original Protocol requires an annual submission from each party of controlled-substance statistical data on its production, approved-process destruction, imports, exports to other parties, and exports to non-parties.80

b. Textual Modifications

The substantive rules governing the parties’ cooperative preservation of the ozone layer are of course found in the ozone treaties. The rules governing textual modifications of those treaties are especially important in light of both the emphasis of the convention-protocol on later enactments and the actual history

76. Id. art. 4(4), at 34. These products were eventually listed, in a rather general fashion, in Annex D of the Protocol.
77. The parties could, of course, also comply with the terms of the Protocol by holding a single meeting, within three years of entry into force, that addressed both incorporated and produced-with substances, but the drafters of the agreement nonetheless treated the two extensions as textually distinct.
78. Montreal Protocol, supra note 41, art. 6, at 35.
79. Id. art. 9, at 35-36.
80. Id. art. 7, at 35.
of the ozone-treaty regime, which has yielded nearly half a dozen distinct Revisions.

The Convention sets out the rules for its own textual modification. The Convention also sets out default rules for any subsequent protocols, and the Original Protocol has not modified these rules.

There are three categories of textual modifications of the Convention or Original Protocol: amendments to non-annex text, amendments to annexes, and adjustments. All amendments to the Convention or Original Protocol are to be adopted at a CoP or MoP, respectively. At either meeting, nations are bound to make "every effort to reach agreement on any proposed amendment to this Convention by consensus," but the parties may instead adopt amendments by a three-fourths majority vote (for Convention amendments) or a two-thirds majority vote (for Original Protocol amendments) so long as "all efforts at consensus have been exhausted." If an amendment is adopted, a party is fully bound only if it later affirmatively ratifies that amendment.

The adoption of the text proposed as an amendment to annexes of the Convention or Original Protocol follows the procedure described above. There is a shift in the procedural presumption with respect to making parties fully bound to amendments to annexes: such amendments are binding upon a party unless it objects. As Article 10 of the Convention states, the annexes of the Convention and Original Protocol are an integral part of the document to which they relate, but may address only scientific, technical, and administrative matters.

The Original Protocol (though not the Convention) also recognizes a category of textual modifications known as "adjustments" rather than "amendments." An "adjustment"

81. See Vienna Convention, supra note 40, arts. 9, 10, at 329-31.
82. See id.
83. See Montreal Protocol, supra note 41, art. 14, at 38 (stating that "[e]xcept as otherwise provided in this Protocol, the provisions of the Convention relating to its Protocols shall apply to this Protocol").
84. See Vienna Convention, supra note 40, art. 9, 10, at 329-31; Montreal Protocol, supra note 41, art. 11, at 36-37
85. Vienna Convention, supra note 40, arts. 9(3), 9(4), at 329-30. "Consensus" in international law is not entirely well defined, but the essential idea is that a consensus exists when no party has raised a formal objection to the proposal under discussion. See 1 ENCYCLOPEDIA OF PUBLIC INTERNATIONAL LAW 759-60 (Peter Macalister-Smith ed., 1992).
86. Montreal Protocol, supra note 41, art. 2(9), at 32-33.
may take either of two forms: it may be a change in the ODP of an already-controlled substance, or it may be a reduction in the Allowable Percentage of an already-controlled substance.\textsuperscript{87} As with amendments to the Original Protocol, all adjustments are to be made at a MoP, with the member nations obliged to make "every effort" to adopt adjustments only by consensus;\textsuperscript{88} and a two-thirds majority vote of the parties is necessary for adoption of an adjustment once efforts to achieve a consensus have failed.\textsuperscript{89} Beyond these requirements, the adoption of an adjustment requires separate simple majorities of each of the developed and developing nations voting on the adjustment.\textsuperscript{90}

Surmounting these procedural hurdles yields an important benefit, at least from the standpoint of imposing binding legal obligations upon parties to the Original Protocol: six months after adoption, adjustments become binding on all parties to the adjusted instrument.\textsuperscript{91} In contrast, as previously discussed, non-annex amendments are binding only on the ratifying parties, and annex amendments are binding only on the parties that fail to object.\textsuperscript{92} An adopted adjustment therefore leads to a rule that applies uniformly to all parties to the adjusted Protocol, whereas adopted amendments bind only those parties that take the necessary steps to express their approval of the relevant amendment (or, in the case of an amendment to an annex, that fail to object). Table Two summarizes the panoply of options and requirements relating to textual amendment of the ozone treaties.

\textsuperscript{87} See id.
\textsuperscript{88} See id. art. 2(9)(c), at 33.
\textsuperscript{89} See id.
\textsuperscript{90} See id.
\textsuperscript{91} See id. art. 2(9)(d), at 33.
\textsuperscript{92} See Vienna Convention, supra note 40, arts. 9, 10, at 329-30.
### Table Two

**Amending the Ozone Treaties**

<table>
<thead>
<tr>
<th>Source of Text</th>
<th>Necessary Vote</th>
<th>Pre-Conditions for Binding a Party</th>
</tr>
</thead>
<tbody>
<tr>
<td>Convention</td>
<td>3/4</td>
<td>Ratification by that party</td>
</tr>
<tr>
<td>Protocol</td>
<td>2/3</td>
<td>Ratification by that party</td>
</tr>
<tr>
<td>Convention Annex</td>
<td>3/4</td>
<td>Absence of objection by that party</td>
</tr>
<tr>
<td>Protocol Annex</td>
<td>2/3</td>
<td>Absence of objection by that party</td>
</tr>
<tr>
<td>Adjustments (OPDs and Allowable Percentages in Protocol)</td>
<td>2/3 (must include simple majorities of both developed and developing nations)</td>
<td>None</td>
</tr>
</tbody>
</table>

To bind parties who do not adopt a text is unusual in international law. The presence of such a mechanism for textual modification in the ozone-treaty regime is thus an indicator of an atypical willingness by participants in the regime to change the terms of their initial cooperative bargain. As will be seen in more
detail below, adjustments have been used to effect important changes in the rules of the ozone treaties—and always to increase the degree of cooperation embodied in the regulations of the ozone treaties.

c. Duration and Membership

From an iterative perspective, a treaty of indefinite duration is optimal; the shadow of the future is thereby maximally lengthened. Both the Convention and the Original Protocol fail to state their duration explicitly and thus, under the default rule generally applicable to treaties, are of indefinite duration.

Multilateral treaties raise issues relating not only to the duration of the instrument as a whole, but also to the entry and exit of individual nations. The entry requirements of the Convention and the Original Protocol are similar to those imposed by virtually all multilateral treaties: the signature of an authorized representative of the relevant nation-state, together with subsequent ratification by the relevant head of state.93 As with most modern treaties, the Convention and the Original Protocol also permit non-signatories to “accede” and thus be treated as if they had both signed and ratified.94

The ozone treaties’ rules on exit are less conventional. From the iterative perspective, any limitation on the exit of individual parties is useful. Indeed, an outright bar against exit is presumably best, for the same reasons that support an indefinite duration as the default length of time during which a treaty is effective after its entry into force, i.e. the parties are required to cooperate for the indefinite future. The default rule of the law of treaties comes quite close to the ideal rule relating to withdrawal: although that default rule does not bar exit, it does condition a party’s withdrawal upon the unanimous consent of the other parties to the treaty.95

The typical practice of treaty drafters, however, has been to override the default rule by adopting a provision that allows any party to withdraw unilaterally after the lapse of a brief notification period. Indeed, although a requirement that a withdrawing party meet some substantive pre-condition might serve as a partial

93. See id. arts. 12-14, at 331-32.
94. See id. art. 14, at 332.
95. See Law of Treaties, supra note 31, art. 54, at 344-45.
equivalent to a no-withdrawal rule, most treaties allow withdrawal upon nothing more than a bare-bones notification and the lapse of the requisite time.

The ozone treaties are more consistent with the iterative perspective on withdrawal than is the typical treaty. A party may not withdraw at all from either the Convention or the Original Protocol for the first four years after the relevant agreement binds that party. After the expiration of this no-withdrawal period, a party must provide a full year's notice before its withdrawal from the relevant agreement becomes effective.

If one believes that the first rounds of participation by a party in an iterative process are especially important, then the first-four-years no-withdrawal provisions are especially useful. In any case, these no-withdrawal provisions distinguish the ozone treaties from many other international agreements. And while the one-year notification provision subsequently applicable is not qualitatively different from the typical treaty, one may at least say with confidence that the notification period is longer (and thus presumptively superior from the iterative perspective) than that of many other treaties. Indeed, I am not aware of any treaty with a longer mandated notification period. Like most treaties, however, the ozone treaties do not require a withdrawing party to possess or state any particular reason for its withdrawal; in this aspect, the ozone treaties are no more consistent with the iterative perspective than are many other international agreements.

d. Interpretation, Compliance, and Enforcement

A treaty crafted with attention to the iterative perspective should reflect the possibility that a party will initially cooperate with the treaty regime by formally consenting to its terms, but later defect by failing to perform its obligations. Those who implicitly analogize international law to domestic criminal law call such behavior a treaty "violation," and they ponder what "sanction" or "punishment" is appropriate in order to eliminate and deter violations. Other scholars—perhaps sympathetic to the almost inevitable disappointment that such an analogy will generate, yet desirous not to abandon the field of international law as a hopeless

97. See supra note 96.
cesspool of illegality—have analogized international law to a complex regulatory regime. In this view, the metric is a more flexible degree of "compliance," and the compliance-oriented group emphasize that treaties involve the unfolding interactions of rules that may be poorly specified as well as behavior that may be motivated by ignorance or incapacity or by intentional disobedience.

International environmental treaties (as well as arms-control treaties) are a favored topic of the compliance-oriented group, and the ozone treaties are frequently cited as an example of a complex regulatory treaty. The structure of the ozone treaties' mechanisms for resolving disputes about the consistency between text and behavior are certainly much more tentative (and iterative) than they are decisive and definitive, and are thus more consistent with the compliance-oriented than with the other enforcement-oriented school.

The Convention devotes an article to the explicit specification of a dispute-resolution mechanism. That mechanism is plainly iterative. It involves several choices by the parties rather than a mandatory linear progression, however, and it need not lead to an actual resolution of every dispute. Under Article 11 of the Convention, parties to a dispute must first attempt to resolve their differences through negotiation between themselves.93 If negotiation fails, then the parties may (but need not) seek the mediation of a third party.99 If mediation fails (or is not attempted), then parties who have not agreed otherwise in advance must submit their dispute to a "conciliation commission," which must issue "a final and recommendatory award, which the parties shall consider in good faith."100 Even if parties adhere to their legal obligations under Article 11, therefore, the dispute-resolution mechanism may fail to resolve a dispute—if, for example, one party considers the final and recommendatory award in good faith but rejects that award nonetheless.

While recommendatory conciliation is the default mechanism of last resort for resolving disputes, the drafters of the Convention also allowed for compulsory dispute resolution. A party may, either generally or with respect only to a particular dispute,

98. Vienna Convention, supra note 40, art. 11(1), at 311.
99. See id. art. 11(2), at 311.
100. Id. art. 11(5), at 311.
commit itself to one (or both) of two forms of compulsory dispute resolution: binding arbitration or submission of the dispute to the International Court of Justice.\textsuperscript{101} If both parties have committed themselves to the same form (or to both forms), then a compulsory form of dispute resolution is used instead of recommendatory conciliation.\textsuperscript{102}

All of these dispute-resolution provisions in the Convention apply as well to disputes under the Original Protocol. The Convention made its provisions presumptively binding on all protocols, and the Original Protocol does not override this presumption.

As mentioned above, the Original Protocol also requires the parties, at their first MoP, to consider and approve “procedures and institutional mechanisms for determining non-compliance with the provisions of the Montreal Protocol and for the treatment of Parties that fail to comply with its terms.”\textsuperscript{103}

With the exception of the last-discussed non-compliance mechanism, the Convention and Original Protocol are typical of recent treaties in the depth and focus on iteration of their dispute-resolution mechanisms.\textsuperscript{104} The non-compliance mechanism developed for the ozone-treaty regime is more extensive than that associated with the typical treaty. This mechanism, however, evolved after the enactment of the Convention and Original Protocol and so I defer an extensive discussion of that mechanism. It is noteworthy, however, that the seed of the Original Protocol has blossomed into a mechanism that the parties regularly employ.

e. Conclusion

Surveying the various input-oriented provisions related to iteration, the ozone treaties demonstrate a greater concern for iteration than the typical treaty. The ozone treaties do not show a dramatically greater encouragement of iteration than every other treaty, nor do they show more concern for iteration along every dimension than does the typical treaty. The Initial Enactments do, however, show a good deal of concern for iteration across a wide variety of dimensions. A formal convention-protocol approach is

\textsuperscript{101} See id. art. 11(3), at 311.
\textsuperscript{102} See id.
\textsuperscript{103} Montreal Protocol, supra note 41, art. 8, at 35.
\textsuperscript{104} See Setear, Iterative Perspective, supra note 13, at 215-16 (discussing dispute resolution mechanisms in other tactics).
relatively rare, yet the ozone treaties display a thoroughgoing convention-protocol approach. The ozone treaties are banal in their general structure of meetings and organizations, but the details evince some freshness in fleshing out that structure with particular topics and time lapses, especially in the later Protocol. The duration of the treaty is as favorable as one may have, though not atypically so. While many of the exit provisions are nearly as inconsistent with the implications of the iterative perspective as one can imagine, similar provisions appear in nearly every other treaty. The limitation on any withdrawals at all during the first few years of operation of each instrument, however, is both relatively rare and consistent with the implications of the iterative perspective. The procedures for textual modifications are different only in degree, not in kind, from the typical provisions on modifications, but those differences favor iteration: affirmative unanimity is never necessary, while adjustments are unusual in binding all parties. The dispute-resolution mechanism is relatively rich in iterations, though it hardly displays the degree of definitiveness evident in the dispute-resolution mechanisms of the European Union (EU)\textsuperscript{105} or the World Trade Organization (WTO).\textsuperscript{106} In this aspect, it is the ozone treaties, rather than the EU and the WTO, that are typical.

III. THE OUTPUTS OF THE ITERATIVE PROCESS

Part One described what one might call the “inputs” of the iterative process: the textual provisions in the Initial Enactments that govern the frequency and subject matters of the parties’ formalized interactions over time. Part One concluded that the drafters of these initial ozone treaties crafted the relevant provisions with a thorough-going, though not theoretically maximal, concern for iteration.

Part Two examines what one might consider to be the “outputs” of the iterative process over time: the textual changes in the Revisions, the expressions of formal consent from nation-states, the degree to which the actual behavior of nation-states has comported with the rules of the ozone treaties, the CoPs and the MoPs through the years, and so on. Because of the particular

structure of treaty law and of the ozone treaties themselves, one may examine many of these outputs in clear and quantifiable form.

This clarity and quantifiability provides at least two advantages over the more typical and undifferentiated arguments that the ozone treaties are a "success." First, for those generally interested in the evolution of cooperation, one may unpack "the" success of the ozone treaties into a variety of components and examine the evolution of each component over time. For example, the number of ozone-depleting substances regulated by the ozone treaties increased by literally an order of magnitude in roughly five years, although the number of chemically distinct groups regulated increased only four-fold. The rules governing the chemicals first regulated by the Original Protocol required several iterations before eventually imposing a ban on those chemicals, while certain of the chemicals first regulated by the Copenhagen Revisions were almost immediately allocated an Allowable Percentage of 0%. This sharp increase in the rapidity of regulating classes of chemical contrasts sharply with the rules governing the parties' response to non-compliance by one of their number, which have evolved at a pace so tentative and stately as to be vaguely reminiscent of the post-Jurassic reptiles.

Second, there are some generalized conclusions about the success and dynamics of the ozone-treaty regime that one can draw much more confidently after having examined, in sometimes numbing detail, the specifics of that regime. The degree of cooperation achieved through the ozone treaties is quite impressive. The number of regulated chemicals has grown dramatically since the Initial Enactments. The number of parties to the regime has mushroomed. The Revisions have tinkered with the exceptions to the core regulatory scheme. And even the non-compliance provisions of the regime are innovative when measured against the backdrop of the vast majority of treaty regimes.

107. See infra Table Three.
108. See Montreal Protocol, supra note 41, art. 2, at 31-33.
110. See infra Table Three.
111. See infra Table Fourteen; see also infra Chart One.
The aggregation of details concerning the evolution of cooperation in the ozone-treaty regime produces not only a sense of impressively broad success but also a sense of regime maturity. The Copenhagen Revisions have failed to garner the burst of initial assets associated with the immediately prior London Revisions, though the London Revisions had outpaced the rate of adoptions associated with their immediate predecessor (the Original Protocol). The parties created the first three versions of the Protocol in five years, increasing the number of regulated chemicals from 0 to 88. In the five years since the adoption of the third version of the Protocol, however, only one new version has issued forth and that revision does not add a single new chemical to the list of regulated substances. Given the broad spectrum of chemicals regulated after the Copenhagen Revisions and the number of outright bans in place after the enactment of the Montreal Revisions, the ozone-treaty regime may well have achieved about all it can by way of rapid expansion. Consolidation of the extant successes under existing textual authority—chiefly in implementing the regime’s redistributive mechanisms in order to persuade the currently unregulated developing nations to comply when they too become fully constrained by the substantive limits of the regime, and in dealing with non-compliance by Russia or others—is presumably the order of the new day.

This Part examines, in essentially the same order that Part One examined the inputs, the outputs of the iterative process instantiated in the ozone treaties: meetings, textual changes, membership, and interpretation and compliance.

First, however, one should note that virtually all of these various outputs are the result of an overarching series of nested iterations stemming from the particular implementation of the general law of treaties in the text of the Initial Enactments. The text of the initial ozone treaties sets forth the procedural mechanisms by which a CoP or MoP can adopt new text and by which (if necessary) the parties later individually indicate their full consent to that new text. These three iterations generally applicable with respect to treaties—negotiations leading to an authoritative text, adoption of

112. See infra Table Fourteen; see also infra Chart One.
113. See infra Table Three.
114. See Report on the Ninth Meeting of the Parties to the Montreal Protocol on Substances that Deplete the Ozone Layer (at Montreal), Sept. 17, 1997, UNEP/OzL.Pro.9/12 [hereinafter Montreal Revisions]; see infra Table Three.
that text, and the expression of full consent to that text—occur with respect to each enactment. The parties to the ozone treaties have chosen to effect a series of such three-iteration enactments, and thus have created the opportunity for parties to cooperate or defect at another level of interaction. The “convention-protocol” approach inherently involves no more inter-instrument iteration than occurs with a convention and a subsequent protocol, i.e., the Initial Enactments, but the parties in this particular case have additionally created nearly half a dozen Revisions, and thus generated an ongoing opportunity for inter-instrument iteration. From the iterative perspective this densely iterative environment is highly consistent with the extensive cooperation that one in fact observes in the ozone regime. The parties have thus sustained a complex network of iteration and meta-iteration through a mixture of mandatory general obligations (e.g., the duty of a ratifying member to observe in good faith all terms of an adopted text ratified by the requisite number of parties), mandatory specific obligations (e.g., the duty of any adopting member to observe in good faith any adjustment adopted by consensus), contemplated but non-mandatory activities (e.g., the Convention’s explicit consideration of how to modify the text of subsequent protocols once the parties choose to enter into them), and entirely discretionary activities (e.g., the decision to propose text for adoption).

A. Meetings

The mere occurrence of meetings is unlikely by itself to convince many observers of a powerful relationship between iteration and cooperation. Meetings without more, after all, need not even attempt to accomplish anything of substance, as those who have watched the modern political perversion of “town meetings” can attest. The Initial Enactments do not in fact set forth particularly onerous requirements.

Nonetheless, a brief description of the meetings relating to the ozone treaties is mildly instructive. First, if no meetings had occurred under the Initial Enactments, then one might view the failure to comply with such a minor obligation as a strong indicator that the parties were unlikely to comply with more burdensome requirements. Second, the meetings that have in fact occurred are sufficiently frequent and varied to indicate not merely perfunctory compliance by the parties with their meeting-related obligations,
but also some significant efforts by the parties to nurture their international legal regime beyond the Initial Enactments. A description of the time, date, and place of the parties’ meetings can thus, when supplemented with a brief description of the textual changes effected at those meetings, serve as an indication of the parties’ compliance with both the letter and the spirit of the Initial Enactments. Third, the parties to the ozone treaties have not met merely to enjoy the vocal stylings of the Helsinki Children’s Choir (the first event at the first MoP), but also to adopt a host of important Revisions. A description of the parties meeting can thus also serve a précis of the more extended discussion undertaken immediately hereafter of the growth in the length, breadth, depth, and coverage of the ozone treaties over time.

The Convention and the Original Protocol entered into force within a few months of one another (September 22, 1988, and January 1, 1989, respectively). The parties convened the first CoP and the first MoP just a few months later, in late April and early May, respectively, of 1989. Since that first gathering, the parties have held sporadic CoPs and annual MoPs. See Table Three. In London in 1990, the MoP adjusted the main body of the Original Protocol and amended both the main body and the annexes of the Original Protocol. In 1992, the MoP was held in Copenhagen, and (as in 1990) both adjusted and amended the main body of the Protocol and amended the annexes. In 1994, the parties returned to Vienna (where the Convention had been signed) to adjust the main body of the Protocol and to change one ODP. In 1997, the parties returned to Montreal (where the Original Protocol had been signed) to adjust and amend the main body of the Original Protocol.


118. See Montreal Revisions, supra note 114. With what one assumes was a certain feeling of symmetry, in light of the first MoP’s choral opening, the parties closed the meeting by thanking the World Children’s Choir of Washington, D.C., for donating 1000 copiés of its compact disk to the UN Environment Program.
## TABLE THREE

### OCCURRENCE OF COPs AND MOPs

<table>
<thead>
<tr>
<th>Year</th>
<th>Convention</th>
<th>Protocol</th>
</tr>
</thead>
<tbody>
<tr>
<td>1989</td>
<td>Met</td>
<td>Met</td>
</tr>
<tr>
<td>1990</td>
<td></td>
<td>Amendments (significant) Adjustments</td>
</tr>
<tr>
<td>1991</td>
<td>Met</td>
<td>Amendments (minor)</td>
</tr>
<tr>
<td>1992</td>
<td></td>
<td>Amendments (significant) Adjustments</td>
</tr>
<tr>
<td>1993</td>
<td>Met</td>
<td>Met</td>
</tr>
<tr>
<td>1994</td>
<td></td>
<td>Met</td>
</tr>
<tr>
<td>1995</td>
<td></td>
<td>Adjustments</td>
</tr>
<tr>
<td>1996</td>
<td>Met</td>
<td>Met</td>
</tr>
<tr>
<td>1997</td>
<td></td>
<td>Adjustments (significant)</td>
</tr>
<tr>
<td>1998</td>
<td></td>
<td>Met</td>
</tr>
</tbody>
</table>

From this bare outline of the meetings, one might make at least a few observations about the contours of the evolution of cooperation in the ozone treaties.

First, the Protocol is the focus of whatever dynamism exists in the ozone-treaty regime. Meetings pursuant to the Protocol have occurred every year; meetings on the Convention have occurred much less often. Meetings pursuant to the Protocol have led to textual changes in the Original Protocol on five occasions; meetings pursuant to the Convention, in contrast, have yet to lead to any textual changes in the main body of that document. And in each year in which the parties did not adopt the Original Protocol or its Revisions, they nonetheless held a MoP at which they discussed various matters of administration, finance, non-compliance, and future textual revisions.\(^{119}\) Given the clearly more

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119. See Report of the First Meeting of the Parties to the Montreal Protocol on the Substances that Deplete the Ozone Layer (at Helsinki), UNEP/OzL.Pro.1/5 (1989) [hereinafter Helsinki Meeting]; Report of the Fifth Meeting of the Parties to the Montreal Protocol on Substances that Deplete the Ozone Layer (at Bangkok), UNEP/OzL.Pro.5/12
specific obligations of the Protocol in comparison to the Convention, one must conclude that the parties are grappling more seriously with the more substantial portion of the convention-protocol treaty regime.

Second, if one accepts for the moment my assessment of which amendments or adjustments are significant, then one might well conclude that these meetings reflect an energetic regime of international cooperation. The parties have met every year. Three of ten MoPs (London, Copenhagen, and Montreal) have involved significant amendments; another MoP (Vienna) involved significant adjustments; and a fifth MoP (Nairobi) involved minor amendments. Roughly every other MoP thus involves some significant textual modifications. Especially in light of the fact that each MoP on a given instrument in a given year has run just three or four consecutive days,120 this pace seems quite lively.

Third, the parties have never been able to effect significant textual changes in consecutive meetings, but the parties have only once held two meetings in a row without adopting a Revision.121 An alternation of a meeting presently concerned with textual revisions, and then one focused on implementation or on the most preliminary consideration of future changes, seems to be the natural rhythm of the meeting iterations. Anyone hoping for MoP after MoP to produce significant textual changes is probably asking too much.

Fourth, the parties have never adopted Revisions during a year that also includes a CoP. (The Nairobi Revisions, a hundred words without immediate substantive impact, are the only exception.) Without more evidence, however, one may plausibly assume either direction for the casual arrow. The parties may be unable, in the limited time available to them, both to address the Convention and the Protocol. Even though a CoP has never

(1993); Report of the Sixth Meeting of the Parties to the Montreal Protocol on Substances That Deplete the Ozone Layer (at Nairobi), UNEP/OzL.Pro.6/7 (1994); Report of the Eighth Meeting of the Parties to the Montreal Protocol on Substances That Deplete the Ozone Layer (at San José), UNEP/OzL.Pro.8/12 (1996).

120. See, e.g., London Revisions, supra note 115 (meeting held 27-29 June 1990); Report of the Third Meeting of the Parties to the Montreal Protocol on Substances that Deplete the Ozone Layer (at Nairobi), UNEP/OzL.Pro.3/11 (1991) (meeting held 19-21 June 1991) [hereinafter Nairobi Revisions]; Copenhagen Revisions, supra note 109, (meeting held 23-25 Nov. 1992); Vienna Revisions, supra note 117 (meeting held 5-7 Dec. 1995); Montreal Revisions, supra note 114, (meeting held 15-17 Sept. 1997).

121. See supra Table Three.
actually amended the main body of the Convention, such gatherings have adopted various Convention annexes and discussed the budget of the secretariat serving both the Convention and the Protocol. Alternatively, it may be that the parties know in advance that no important issues are immediately on the horizon in a given year, and so they schedule both CoP and MoP almost simultaneously to allow exclusive attention in the next year to important changes to the Protocol.

B. Textual Changes

The degree of cooperation associated with a treaty is clearly a function of more than simply the number of meetings that the parties to that treaty undertake. This sub-section examines the rigor of the rules embodied in the ozone treaties over time.

As a result of the particular scheme persistently adopted by the parties to the Protocol, there are two readily quantifiable dimensions of those rules: (1) the number of chemicals (or groups of chemicals) subject to regulation of any kind and (2) the Allowable Percentage for a given group of chemicals in a given year. I call the number of regulated chemicals or groups of chemicals an indication of the “breadth” of the ozone-treaty regime, while I call reductions in the Allowable Percentage an indication of the “depth” of its rules. These dimensions are not only readily quantifiable but also readily associated with judgments about the direction of their impact on the ozone layer. Each increase in the number of regulated chemicals, and each decrease in the Allowable Percentage, reflects greater cooperation with respect to preservation of the ozone layer. One may argue about how much actual impact each change has, and about whether each change produces benefits greater than its costs, and of course about whether parties will comply with each change in the rules. Nonetheless, one would be hard pressed to argue that regulating fewer chemicals or increasing their usage would help to preserve the ozone layer. 122

Next, with some hesitation as to the net utility of the endeavor, I discuss data concerning the number of words in a treaty regime’s texts as a measure of the success of the iterative process. The

122. Additions of chemicals and decreases in Allowable Percentages are both what one might call “unmitigated”—that is, chemicals are added to the list of those regulated, but no other chemicals are simultaneously eliminated; and Allowable Percentages are reduced or remain constant, but never increase.
availability of treaties in on-line form, combined with the word-counting features of computer software, now makes the calculation of the length of a treaty text relatively straightforward. That such calculations actually mean anything may strike many as counter-intuitive. In my view, however, it is worthwhile at least to develop the relevant data, as well as to explore the arguments on each side of the proposition that such calculations are useful.

Finally, I explore a broader, more subjective phenomenon reflected in the ozone regime, which I call its “approaches.” If one were to describe the fundamental approaches to the problem of ozone depletion embodied in the ozone treaties, then one can discern a certain proliferation therein. One might, for example, assert that the Convention embodies one approach involving promises of general substantive cooperation and another approach involving specific promises concerning the procedures to be used in creating future promises. The Original Protocol adds the core regulatory approach. One may discern yet more approaches in the Revisions. One may discuss these approaches in a fashion very roughly similar to the breadth and depth of regulatory rigor described above—although the much more subjective nature of determining the boundaries of an “approach,” in contrast to more objective measurements of breadth or depth or length, imposes some distinct limitations on the analysis.

1. **Breadth**

The core regulatory approach of the ozone treaties’ substantive rules involves the regulation of anthropogenic ozone-depleting chemicals. The Original Protocol and its subsequent Revisions list various ozone-depleting chemicals in their annexes. For each chemical, the relevant annex lists its ODP, a scientifically based estimate of the harm to the ozone layer caused by a molecule of the given chemical. With respect to most chemicals, the annexes gather together several particular chemicals into “groups” sharing the same general chemical structure. (Occasionally there is only one chemical in a so-called “group.”) For example, “Group I” of Annex A consists of five chlorofluorocarbons, a kind of chemical compound containing atoms of chlorine and fluorine and carbon (but no other constituents).\(^{123}\) Three halons, which all contain atoms of chlorine and fluorine and bromine (but no other

constituents), are aggregated into "Group II" of Annex A.124 It is the sum of the ODP-weighted consumption or production of all the chemicals in a group that one uses, in conjunction with the Allowable Percentage, to determine the allowable consumption or production each year.125

Whether measured in terms of individual chemicals or "groups" of chemicals, the breadth of the ozone treaties' regulations has increased (or at least remained the same) with each new document in the series. Table Four summarizes these changes. The Convention did not require reductions in the production or consumption of any chemicals.126 The Original Protocol listed two separate groups of chemicals, the five chlorofluorocarbons and three halons mentioned in the paragraph above.127 The London Revisions retained intact the groupings and chemicals of the Original Protocol; but added another group of chlorofluorocarbons (consisting of nine different chemicals) as well as two one-chemical groups (for carbon tetrachloride and methyl chloroform).128 The Copenhagen Revisions retained all of the previously assigned chemicals and groupings, and added one group of forty different hydrochlorofluorocarbons, one group of thirty-four hydrobromofluorocarbons, and one group consisting only of methyl bromide.129 The post-Copenhagen enactments have left intact the list and groupings of chemicals effected by the Original Protocol, the London Revisions, and the Copenhagen Revisions.130

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124. See id.
125. See id. art. 3, at 33.
126. See Vienna Convention, supra note 40, art. 2(2)(c), at 326 (limiting the parties' general obligations to, inter alia, cooperation "in the formulation of agreed measures, procedures and standards for the implementation of this Convention, with a view to the adoption of protocols and annexes").
127. See Montreal Protocol, supra note 41, art. 2, at 31-33.
128. See London Revisions, supra note 115, arts. 2D, 2E, at 544-45.
129. See Copenhagen Revisions, supra note 109, arts. 2F, 2G, 2H, at 879-81.
130. See Vienna Revisions, supra note 117. Some of the data presented in the various tables herein have been presented in tabular form by other authors, though chiefly as a matter of description rather than as illustrations of a particular theoretical perspective. Edith Brown Weiss and her co-authors present a table that shows developments post-dating the Original Protocol broken down by enactment date and, within each enactment, by chemical. BROWN WEISS ET AL., supra note 1, at 652-58.

David Hunter and his co-authors present a very compact table (thanks in part to the use of tiny type) showing the baseline year of measurement for each group of chemicals and the stringency of regulation for enactments from the Original Protocol through the 1995 Vienna Adjustments. HUNTER ET AL., supra note 1, at 574.
### Table Four

**Chemicals and Chemical Groups Regulated by the Ozone Treaties**

<table>
<thead>
<tr>
<th>Document</th>
<th>Total Groups Regulated</th>
<th>Total Chemicals Regulated</th>
<th>Range of ODPs In Added Groups</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vienna Convention</td>
<td>0</td>
<td>0</td>
<td>----</td>
</tr>
<tr>
<td>Montréal Protocol</td>
<td>2</td>
<td>8</td>
<td>0.6-1.0 (CFCs) 3-10 (halons)</td>
</tr>
<tr>
<td>London Revisions</td>
<td>5</td>
<td>20</td>
<td>1.0 (more CFCs) 1.1 (carbon tetrachloride) 0.1 (methyl chloroform)</td>
</tr>
<tr>
<td>Nairobi Addition</td>
<td>5</td>
<td>20</td>
<td>----</td>
</tr>
<tr>
<td>Copenhagen Revisions</td>
<td>8</td>
<td>95</td>
<td>0.14 or less (HCFCs) 0.3-14.0 (HBFCs) 0.7 (methyl bromide)</td>
</tr>
<tr>
<td>Later Enactments</td>
<td>8</td>
<td>95</td>
<td>----</td>
</tr>
</tbody>
</table>

Thomas Gehring has a similar table through the 1992 Copenhagen Amendments. Thomas Gehring, Dynamic International Regimes: Institutions for International Environmental Governance 312 (1994). Gehring's work also includes a few other tables that involve some portion of several aspects of the tables presented herein. Id. at 284, 285, 303. Generally, Gehring takes a dynamic, though chiefly descriptive, perspective on the ozone treaties. Id. at 195-320; cf. id. at 351-483 (taking a theoretical approach to international regimes, but without specific development of ozone regime).
The breadth of the ozone-treaty regime thus involves a period of intense growth bracketed by periods of perfect inactivity. The Convention regulates no chemicals. The enactments between 1988 and 1992 were responsible for all the changes in breadth. After the Montreal Protocol broke the ice, as it were, the London Revisions and Copenhagen Revisions together quadrupled the Original Protocol's breadth on a per-group basis and increased the Original Protocol's breadth by more than ten times on a per-chemical basis. The post-1992 enactments did not add a single chemical.

Simply counting the number of chemicals and groups implies that all ozone-depleting substances are created equal. One might wonder, however, if early enactments picked unimportant targets to be sure of hitting something. In fact, the Original Protocol regulated those substances thought to be the most threatening to the ozone layer, as measured in terms of a combination of volume of production and ODP. The CFCs were used in great volume, while the halons were used in significant volume and possess very high ODPs. Subsequent enactments regulated the HCFCs largely because they were thought to be viable substitutes for CFCs, which were by that time scheduled to be banned. The scientific data showing that bromine, the crucial component of the last-regulated HBFCs and methyl bromide, is a catalyst of ozone-depleting reactions became available much later than the data showing the catalytic role of chlorine. One may, therefore, conclude that, given the state of scientific knowledge, the parties regulated the most worrisome substances first.

One might also note that the incorporation of chemicals and groups displays a ratchet effect: no chemical or group, once regulated, has been de-regulated.

Speaking both from a purely quantitative and from a partly qualitative perspective, then, the changes over time in the breadth of the ozone-treaty regime are most consistent with what one

131. See Vienna Convention, supra note 20, art. 2(2)(c), at 326 (limiting the parties' general obligations as, inter alia, cooperation "in the formulation of agreed measures, procedures and standards for the implementation of this Convention, with a view to the adoption of protocols and annexes").
132. See supra Table Three.
133. See Vienna Revisions, supra note 117; Montreal Revisions, supra note 114.
134. See London Revisions, supra note 115, art. 2, at 542-45; Copenhagen Revisions, supra note 109, art. 2, 878-81; Vienna Revisions, supra note 117; Montreal Revisions, supra note 114.
might call a "matured" evolution of cooperation. The first enactment regulates no chemicals, followed by a phase of three enactments over four years in which the breadth of the system grows rapidly in both numerical terms and effectiveness, and finally followed by a phase of at least as many years in which no further expansion occurs.

2. Depth

a. Summary

The particulars of the regulatory scheme adopted by the ozone treaties lend themselves to a quantitative examination of the changes over time in the rigor of their strictures, which I call their "depth." For each group of chemicals within the scope of a given document's regulations, there is a reduction in the Allowable Percentage associated with each particular year in the future of the regime. For example, the Original Protocol specifies that, in 1999, each nation's Allowable Percentage of the five CFCs in Group I of Annex A shall be 50% of that nation's aggregate ODP-weighted consumption or production of those chemicals in the baseline year.135 Moreover, for many chemicals, subsequent enactments specify additional reductions in the Allowable Percentage over time.136

One may, therefore, examine the changes over time in the relevant percentages in two different ways: within a given document and across documents. Along both dimensions, there is a monotonic decrease over time in the Allowable Percentage for every group of chemicals addressed. In any given enactment, the Allowable Percentages always either decrease or remain constant over time for each group of chemicals;137 across relevant enactments for a given group of chemicals, the Allowable Percentages likewise always either decrease or remain constant.

136. For example, the London Revisions quicken this timetable, specifying that in 1997 each nation's Allowable Percentage of the chemicals in Group I of Annex A shall be 15% of that nation's calculated levels of consumption or production in the baseline year. London Revisions, supra note 115, art. 2, para. 4, at 539. The Copenhagen Revisions further accelerate the reduction by specifying that beginning in 1996 the Allowable Percentage of these same chemicals shall be reduced to zero. Copenhagen Revisions, supra note 109, art. 2(4), at 876.
137. See infra Tables Four through Ten.
over time. The intra-enactment trend is consistent with a belief by the parties at a given time that future iterations promise greater cooperation (in the form of stricter standards in later years); the inter-enactment trend reflects the realization of greater cooperation by the parties (in the form of stricter standards in a subsequent enactment) in future iterations.

2. Specific Chemical Groups

As mentioned above, the Original Protocol addressed two groups of chemicals: five CFCs (known somewhat unimaginatively as CFC-11, CFC-12, CFC-113, CFC-114, and CFC-115), and three halons (described with equal pragmatism as halon-1211, halon-1301, and halon-2402).

The Original CFCs. With respect to the five “original” CFCs, the Original Protocol left them unregulated until “the twelve-month period commencing on the first day of the seventh month following the date of entry into force of this Protocol.” (Entry into force was contemplated by the drafters of the treaty as, and proved in fact to be, January 1, 1989.) For that first regulated twelve-month period, and for all subsequent twelve-month periods, the Allowable Percentage for the five CFCs constituting Group I of Annex A was 100%. (One might call this a “freeze” on consumption and production, although the aggregation of chemicals within a group allowed parties some flexibility to vary levels of production and consumption of chemicals within the group.) For the period from mid-1993 through mid-1994, the relevant Allowable Percentage was reduced to 80%; by the twelve-month period commencing in mid-1998 (and for all subsequent twelve-month periods), the relevant Allowable Percentage dropped to 50%.

The London Revisions tightened this regulatory scheme, and the Copenhagen Revisions tightened the regulation of the five original CFCs still further. For the period spanning mid-1996 through mid-1997, for example, the Original Protocol specified the Allowable

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138. See id.
140. Id. art. 2(1), at 31.
141. Id. art. 16, at 38.
142. Id. art. 2(1), at 31.
143. Id. art. 2(3), at 31.
144. Id. art. 2(4), at 31-32.
Percentage for the five original CFCs be 80%;\textsuperscript{145} the London Revisions further reduced the relevant Allowable Percentage to 50% for 1996;\textsuperscript{146} and the Copenhagen Revisions specified 0% as the relevant Allowable Percentage for that year.\textsuperscript{147} (One might call a 0% Allowable Percentage a "ban" on the consumption and production of the relevant substances, although the treaty in fact sets forth some exceptions to the Allowable Percentages that operate to still permit some continuing consumption and production of the five original CFCs without violating the treaty.\textsuperscript{148}) Table Five sets forth these Allowable Percentages for all periods covered by each ozone enactment. (Post-Copenhagen documents did not further reduce the Allowable Percentage for CFCs;\textsuperscript{149} by the time that such documents could have entered into force, the Copenhagen Revisions already mandated a 0% Allowable Percentage.)

\textsuperscript{145} Id. art. 2(3), at 31.
\textsuperscript{146} London Revisions, supra note 115, art. 2(3), at 539.
\textsuperscript{147} Copenhagen Revisions, supra note 109, art. 2A(4), at 876.
\textsuperscript{148} Montreal Protocol, supra note 41, art. 2(5), at 32 (industrial rationalization); id. art. 5, at 34-35 (basic domestic needs of developing nations).
\textsuperscript{149} Compare Vienna Revisions, supra note 117, and Montreal Revisions, supra note 114, with Copenhagen Revisions, supra note 109, art. 2A(4), at 876.
### Table Five

**Allowable Percentages for Group I of Annex A (Original CFCs)**

<table>
<thead>
<tr>
<th>Enactment</th>
<th>Protocol</th>
<th>London Revisions</th>
<th>Copenhagen Revisions</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Initial Period</strong></td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td><strong>1993</strong></td>
<td>80%</td>
<td>80%</td>
<td>80%</td>
</tr>
<tr>
<td><strong>1994</strong></td>
<td>80%</td>
<td>80%</td>
<td>25%</td>
</tr>
<tr>
<td><strong>1995</strong></td>
<td>80%</td>
<td>50%</td>
<td>25%</td>
</tr>
<tr>
<td><strong>1996</strong></td>
<td>80%</td>
<td>50%</td>
<td>0%</td>
</tr>
<tr>
<td><strong>1997</strong></td>
<td>80%</td>
<td>15%</td>
<td>0%</td>
</tr>
<tr>
<td><strong>1998</strong></td>
<td>50%</td>
<td>15%</td>
<td>0%</td>
</tr>
<tr>
<td><strong>1999</strong></td>
<td>50%</td>
<td>15%</td>
<td>0%</td>
</tr>
<tr>
<td><strong>2000 and each later year</strong></td>
<td>50%</td>
<td>0%</td>
<td>0%</td>
</tr>
</tbody>
</table>

*The Halons.* Three chemicals—halon-1211, halon-1301, and halon-2402—comprise Group II of Annex A. The regulation of halons did not begin as quickly as did the regulation of the original CFCs, and the Allowable Percentage in a given year for halons was typically greater than the Allowable Percentage for CFCs in that same year. Nonetheless, the trend towards stricter regulation, with an ultimate reduction in the Allowable Percentage to 0%, encompasses not only the original CFCs but also the halons.

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151. *See id.* art. 2(2), at 31.
Copenhagen Revisions. Again, there is no need to display post- Copenhagen enactments because such enactments did not modify the regulation of halons.

### Table Six

**Group II of Annex A (Halons)**

<table>
<thead>
<tr>
<th>Enactment</th>
<th>Protocol</th>
<th>London Revisions</th>
<th>Copenhagen Revisions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial Period</td>
<td>Not regulated</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>Next Three Years</td>
<td>100%</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>1992</td>
<td>---</td>
<td>100%</td>
<td>---</td>
</tr>
<tr>
<td>1993</td>
<td>---</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td>1994</td>
<td>100%</td>
<td>100%</td>
<td>0%</td>
</tr>
<tr>
<td>1995</td>
<td>100%</td>
<td>50%</td>
<td>0%</td>
</tr>
<tr>
<td>1996</td>
<td>100%</td>
<td>50%</td>
<td>0%</td>
</tr>
<tr>
<td>1997</td>
<td>100%</td>
<td>50%</td>
<td>0%</td>
</tr>
<tr>
<td>1998</td>
<td>100%</td>
<td>50%</td>
<td>0%</td>
</tr>
<tr>
<td>1999</td>
<td>100%</td>
<td>50%</td>
<td>0%</td>
</tr>
<tr>
<td>2000 and after</td>
<td>100%</td>
<td>0%</td>
<td>0%</td>
</tr>
</tbody>
</table>

*Note:* For the Original Protocol, the year shown above designates an annum beginning on July 1st of the year shown and continuing until June 30th of the subsequent calendar year. For the London Revisions and the Copenhagen Revisions, the year shown above designates an annum beginning on January 1st of the year shown and continuing until December 31st of that same calendar year.
The "Follow-on" CFCs. The London Revisions added ten CFCs—CFC-13, CFC-111, CFC-112, and CFCs -211 through -217—to the list of regulated chemicals.154 These ten newly regulated CFCs constituted Group I of Annex B, which I call the "follow-on" CFCs. The London Revisions stated that, beginning in 1993, the Allowable Percentage for follow-on CFCs would be 80%; beginning in 1997, the relevant Allowable Percentage was to be 15%; beginning in 2000, the relevant Allowable Percentage was to be 0%.155 The Copenhagen Revisions retained the London Revisions’ 80% ceiling for 1993.156 For 1994 and 1995, however, the relevant Allowable Percentage was reduced from 80% to 25%.157 Beginning in 1996, the relevant Allowable Percentage was to be 0%.158 Practically speaking, no post-Copenhagen enactments could have entered into force before the 0% Allowable Percentage, and post-Copenhagen amendments leave in place the Allowable Percentages set forth in the Copenhagen Revisions.159

Table Seven sets forth the relevant Allowable Percentages. Note that, because the Original Protocol did not regulate these substances, only two, rather than three, enactments regulate the relevant chemicals.

155. Id. art. 2C, at 543-44.
156. See Copenhagen Revisions, supra note 109, art. 2(C)(1), at 877.
157. Id. art. 2(C)(2), at 877.
158. See Id. art. 2(C)(3), at 877.
159. See Vienna Revisions, supra note 117; Montreal Revisions, supra note 114.
TABLE SEVEN

GROUP I OF ANNEX B (FOLLOW-ON CFCs)

<table>
<thead>
<tr>
<th>Enactment</th>
<th>London Revisions</th>
<th>Copenhagen Revisions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before</td>
<td>Not regulated</td>
<td>Not regulated</td>
</tr>
<tr>
<td>1993</td>
<td>80%</td>
<td>80%</td>
</tr>
<tr>
<td>1994</td>
<td>80%</td>
<td>25%</td>
</tr>
<tr>
<td>1995</td>
<td>80%</td>
<td>25%</td>
</tr>
<tr>
<td>1996</td>
<td>80%</td>
<td>0%</td>
</tr>
<tr>
<td>1997</td>
<td>15%</td>
<td>0%</td>
</tr>
<tr>
<td>1998</td>
<td>15%</td>
<td>0%</td>
</tr>
<tr>
<td>1999</td>
<td>15%</td>
<td>0%</td>
</tr>
<tr>
<td>2000 and after</td>
<td>0%</td>
<td>0%</td>
</tr>
</tbody>
</table>

Carbon Tetrachloride and Methyl Chloroform. The London Revisions added carbon tetrachloride, a compound familiar to domestic environmental regulators as an important dry-cleaning solvent, to the list of regulated ozone-depleting substances as the only chemical in Group II of Annex B.\(^{160}\) Those Revisions likewise added methyl chloroform as the only chemical in Group III of that Annex.\(^{161}\) Following a pattern that may now seem familiar, the Copenhagen Revisions further tightened the Allowable Percentages for both chemicals, including a reduction to 0% effective soon after the Copenhagen Revisions entered into force,\(^{162}\) and post-Copenhagen enactments in the ozone treaties have left in place the Allowable Percentages set forth in the Copenhagen Revisions.\(^{163}\) See Tables Eight and Nine.

161. Id.
162. Copenhagen Revisions, supra note 109, arts. 2D, 2E, at 877-78.
163. See Montreal Revisions, supra note 114; Vienna Revisions, supra note 117.
### Table Eight

**Group II of Annex B (Carbon Tetrachloride)**

<table>
<thead>
<tr>
<th>Enactment</th>
<th>London Revisions</th>
<th>Copenhagen Revisions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before 1993</td>
<td>Not regulated</td>
<td>Not regulated</td>
</tr>
<tr>
<td>1993</td>
<td>Not regulated</td>
<td>Not regulated</td>
</tr>
<tr>
<td>1994</td>
<td>Not regulated</td>
<td>Not regulated</td>
</tr>
<tr>
<td>1995</td>
<td>15%</td>
<td>15%</td>
</tr>
<tr>
<td>1996</td>
<td>15%</td>
<td>0%</td>
</tr>
<tr>
<td>1997</td>
<td>15%</td>
<td>0%</td>
</tr>
<tr>
<td>1998</td>
<td>15%</td>
<td>0%</td>
</tr>
<tr>
<td>1999</td>
<td>15%</td>
<td>0%</td>
</tr>
<tr>
<td>2000 and after</td>
<td>0%</td>
<td>0%</td>
</tr>
</tbody>
</table>
TABLE NINE

GROUP III OF ANNEX B (METHYL CHLOROFORM)

<table>
<thead>
<tr>
<th>Enactment</th>
<th>London Revisions</th>
<th>Copenhagen Revisions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before 1993</td>
<td>Not regulated</td>
<td>Not regulated</td>
</tr>
<tr>
<td>1993</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td>1994</td>
<td>100%</td>
<td>50%</td>
</tr>
<tr>
<td>1995</td>
<td>70%</td>
<td>50%</td>
</tr>
<tr>
<td>1996</td>
<td>70%</td>
<td>0%</td>
</tr>
<tr>
<td>1997</td>
<td>70%</td>
<td>0%</td>
</tr>
<tr>
<td>1998</td>
<td>70%</td>
<td>0%</td>
</tr>
<tr>
<td>1999</td>
<td>70%</td>
<td>0%</td>
</tr>
<tr>
<td>2000 through</td>
<td>30%</td>
<td>0%</td>
</tr>
<tr>
<td>2004 (per year)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2005 and after</td>
<td>0%</td>
<td>0%</td>
</tr>
</tbody>
</table>

HCFCs. These 34 chemicals, added to the substances regulated by the ozone treaties with the Copenhagen Revisions, do not fit the typical pattern of progressive tightening over time. The Copenhagen Revisions set up a progressively tighter Allowable Percentage for HCFCs, but no later enactments further reduce those Allowable Percentages despite the fact that the Copenhagen Revisions do not mandate a 0% Allowable Percentage until 2030.164 The relevant Allowable Percentages are: 65% from 2004 to 2009; 35% from 2010 to 2014; 10% from 2015 to 2019; 0.5% from 2020 to 2029; and 0% thereafter.165 This Allowable Percentage, it should be noted, is to be applied against a baseline measuring the 1989 Allowable Percentage for the 34 HCFCs plus 3.1% of the 1989 Allowable Percentage for the five original CFCs.

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164. Compare Copenhagen Revisions, supra note 109, art. 2F(6), at 880 (delaying complete ban until 2030), with Vienna Revisions, supra note 117, and Montreal Revisions, supra note 114.

165. See Copenhagen Revisions, supra note 109, art. 2F, at 879-80.
(Consistent with the fact that a nation employing more CFCs in 1989 is by this formula allowed to use more HCFCs in later years, the HCFCs are viewed as a transitional substitute for CFCs.)

**HBFCs.** The HBFCs are the international environmental equivalent of every second-stringer's nightmare: they enter into play only late in the game, and then they are immediately and permanently banished from the field. The Copenhagen Revisions, which entered into force in mid-1994, are the first enactment to treat the HBFCs, and those Revisions impose a 0% Allowable Percentage beginning in 1996. Like HCFCs, therefore, they deviate to some degree from the model of repeated tightening of the Allowable Percentages that characterizes the treatment by the ozone treaties of the original CFCs, the halons, the follow-on CFCs, carbon tetrachloride, methyl chloroform, and, as discussed immediately below, methyl bromide.

**Methyl Bromide.** The Copenhagen Revisions are the first document to regulate methyl bromide, a commonly used soil fumigant and a by-product of both biomass burning and internal combustion using leaded gasoline. In contrast to the other chemicals first regulated by the Copenhagen Revisions, however, methyl bromide is also the subject of stricter regulation in subsequent Revisions. The Copenhagen Revisions simply place a freeze on the consumption and production of methyl bromide with respect to the baseline-year consumption or production in 1991. The Vienna Revisions retain this freeze through the end of the twentieth century, but then begin to ratchet down the Allowable Percentages for methyl bromide through 75% (from 2001-2004) and 50% (from 2005-2009) on the way to 0% in 2010. The Montreal Revisions begin the sub-100% ratcheting two years earlier and impose a 0% Allowable Percentage by 2005. Table Ten compares the depth of regulation in the various documents.

One might also note that methyl bromide is an exception to the usual special treatment accorded developing countries by the ozone treaties. A developing country consuming fewer than 0.3 kilograms per capita of ozone-depleting substances may delay for ten years its compliance with the particulars of the Allowable Percentage-reduction scheme of the treaties so long as its

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166. *Id.* art. 2G, at 880.
167. *Id.* art. 2H, at 880-81.
consumption continues to be fewer than 0.3 kilograms per capita.\textsuperscript{169} Under the Vienna Revisions, however, even a developing nation must abide in a given year by specified Allowable Percentages for methyl bromide.\textsuperscript{170} (The timetable is different from that adopted for developed nations, however.) The Montreal Revisions further tighten these regulations, moving up the initiation of a 0\% Allowable Percentage by a full quarter of a century.\textsuperscript{171} Table Eleven summarizes these regulations (including the non-regulations of the Copenhagen Revisions, in order to allow the most directly parallel comparison between the regulation of methyl bromide in developed countries, as shown in Table Ten, and in developing countries).

\textbf{Table Ten}

\textbf{Annex E (Methyl Bromide) Basic Regulation (Developed Nations)}

<table>
<thead>
<tr>
<th>Enactment</th>
<th>Copenhagen Revisions</th>
<th>Vienna Adjustments</th>
<th>Montreal Revisions</th>
</tr>
</thead>
<tbody>
<tr>
<td>1995</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td>1996</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td>1997</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td>1998</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td>1999</td>
<td>100%</td>
<td>100%</td>
<td>75%</td>
</tr>
<tr>
<td>2000</td>
<td>100%</td>
<td>100%</td>
<td>75%</td>
</tr>
<tr>
<td>2001</td>
<td>100%</td>
<td>75%</td>
<td>50%</td>
</tr>
<tr>
<td>2002</td>
<td>100%</td>
<td>75%</td>
<td>50%</td>
</tr>
<tr>
<td>2003</td>
<td>100%</td>
<td>75%</td>
<td>30%</td>
</tr>
<tr>
<td>2004</td>
<td>100%</td>
<td>75%</td>
<td>30%</td>
</tr>
<tr>
<td>2005 - 09</td>
<td>100%</td>
<td>50%</td>
<td>0%</td>
</tr>
<tr>
<td>2010 and after</td>
<td>100%</td>
<td>0%</td>
<td>0%</td>
</tr>
</tbody>
</table>

\textit{Note:} The baseline year for the relevant calculation is 1991.

\textsuperscript{169} See Montreal Protocol, \textit{supra} note 41, art. 5(1), at 34.
\textsuperscript{170} Vienna Revisions, \textit{supra} note 117, art. 5, para. 8 \textit{ter}.
\textsuperscript{171} Montreal Revisions, \textit{supra} note 114, Annex III art. 5, para. 8 \textit{ter} (d)(iii).
### Table Eleven

**ANNEX E (METHYL BROMIDE)—BASIC REGULATION (DEVELOPING NATIONS)**

<table>
<thead>
<tr>
<th>Enactment</th>
<th>1995 to 2004</th>
<th>2005 to 2014</th>
<th>2015</th>
<th>2016 to 2039</th>
<th>2040 and each later year</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Copenhagen Revisions</strong></td>
<td>No regs apply</td>
<td>No regs apply</td>
<td>No regs apply</td>
<td>No regs apply</td>
<td>No regs apply</td>
</tr>
<tr>
<td><strong>Vienna Revisions</strong></td>
<td>No regs apply</td>
<td>No regs apply</td>
<td>No regs apply</td>
<td>100% of 2015 consumption</td>
<td>0%</td>
</tr>
<tr>
<td><strong>Montreal Revisions</strong></td>
<td>No regs apply</td>
<td>80% of 1995-1998 Average of production and consumption</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
</tbody>
</table>

Over and over, and with respect to both aspects of regulatory depth, one sees the same pattern. In a given enactment, the Allowable Percentage either remains constant over time or decreases over time. From enactment to enactment, the Allowable Percentage in a given year likewise either remains constant or decreases. Such a system would seem to involve increasing or constant cooperation under most reasonable definitions thereof.
These two trends have certainly combined to create an extremely strict set of Allowable Percentages for the relevant substances. For every regulated group of chemicals in the ozone-treaty regime, the most recent enactment changing that group's Allowable Percentages sets an Allowable Percentage of 0% for some year. For six of the eight groups of chemicals regulated by the ozone-treaty regime, that year is 1996.172 For methyl bromides, that year is 2005;173 for the CFC-substitute HCFCs, the earliest year with a 0% Allowable Percentage is 2030.174

As with the measurement of temperature in degrees Kelvin, zero is about as low as one may go in specifying Allowable Percentages. In addition, if the ratchet-like quality of the depth of regulation in the ozone-treaty regime persists, then the specification of an Allowable Percentage of 0% in a given year specifies both a theoretically and permanently maximal degree of cooperation for that year. If the current year is already a year in which the Allowable Percentage for a group is 0%, then one must judge the treatment of that group of chemicals to have matured. As with breadth, then, the ozone-treaty regime must in some sense now be considered "mature" with respect to the depth of six of the eight groups of chemicals that it currently regulates.

One may use the dynamics of cooperation with respect to those six groups to make a prediction about the remaining two groups: they do not appear likely to be subject soon to the maximum possible depth of regulation.

For seven of the eight groups regulated by the Protocol, either the first enactment regulating the group set the Allowable Percentage to 0% in the very near future, or the immediately subsequent enactment imposed further reductions on the Allowable Percentages for that group.175 The exception to this rule is the HCFCs. The Copenhagen Revisions were the first enactment regulating HCFCs; those Revisions do not set a 0% Allowable Percentage for HCFCs until 2030;176 and neither of the Revisions following the Copenhagen Revisions addresses HCFCs.177 With respect to this group, no repeated interactions

172. See supra Tables Four through Eight.
173. See supra Table Nine.
174. See Copenhagen Revisions, supra note 109, art. 2F(6), at 880.
175. See supra Tables Four through Nine.
176. See Copenhagen Revisions, supra note 109, art. 2F(6), at 880.
177. See Vienna Revisions, supra note 117; Montreal Revisions, supra note 114.
with a steady (and ratcheted) increase in the depth of cooperation appears to be underway.

Methyl bromide is the other group of chemicals with respect to which an Allowable Percentage of 0% is not already in place. The Copenhagen Revisions were the first enactment to regulate methyl bromide. See Table Ten. They set an Allowable Percentage of 100% for methyl bromide for each year from 1995 onward. The immediately subsequent Vienna Revisions imposed an Allowable Percentage of 75% beginning in 2001 and an Allowable Percentage of 0% in 2010. The Montreal Revisions changed the first 75% Allowable Percentage to 1999 and the first 0% Allowable Percentage to 2005. Methyl bromide thereby achieved a distinction indicating a certain intractability in its control at least compared to other substances regulated by the ozone-treaty regime: methyl bromide is the only substance in the ozone regime to be the subject of more than one enactment that, by the third enactment, has not had a future Allowable Percentage of 0%. In contrast to the treatment of HCFCs, however, the parties have been willing to revisit the Allowable Percentages regulating methyl bromide in enactments subsequent to the initial enactment regulating the group, so perhaps the fourth time will be the “charm” for the near-term-0%-Allowable Percentage regulation of methyl bromide.

3. Length

In the most banal sense, the output of a treaty process consists of words on paper. The re-conversion of those words from ink-on-paper to electrons allows one to count this output with relative ease. I set forth a variety of measurements of the length of the ozone treaties and then discuss a variety of arguments addressed to the question of whether such a mechanical measurement is of any actual utility.

In English, the Vienna Convention is about 5800 words long, including roughly 1500 words contained in two annexes that

178. See Copenhagen Revisions, supra note 109, art. 2H, at 880-81.
179. Vienna Revisions, supra note 117, art. 2H(2), (4).
181. Although some definitional questions are likely to remain with any treaty (e.g., which language to use, whether to count the words in the captions of articles, and so forth) even after one has found a suitable on-line version of the text and a computer capable of counting words.
elaborate upon the particulars of scientific research and cooperation described in the main text. The Original Protocol is roughly 4400 words in length, with about 100 of those words contained in an annex listing a handful of ozone-depleting substances and their ozone-depleting potential.

The proper treatment of Revisions in the ozone-treaty regime is, even with respect to the relatively mechanical measurement of the number of words therein, somewhat ambiguous. In contrast to the Initial Enactments, the Revisions cannot stand on their own; they instead consist of amendments or adjustments to the Original Protocol. Each of these Revisions (with the exception of the Nairobi Addition) contains both some passages of text designed to replace previously enacted provisions and some passages that are purely additive. For example, the London Revisions contain some text that effects the stricter regulation of the original CFCs, which were already regulated in the Original Protocol, as well as some text that sets forth rules on a Multilateral Fund (for technology transfer), an entity completely absent from the Original Protocol.

One obvious response to this a situation is to count not the length in words of each enactment but rather the length in words of the composite document that results from incorporating the changes and additions of the latest enactment into the previously existing version. With a bit of work, one can certainly create such a composite document. "Mere" replacement text then disappears for counting purposes, while "true" additions continue to show up as additional text.

There is, nonetheless, some appeal to a quantification that simply counts the words in each enactment, replacements, additions, preamble, and all. First, such an approach is a measure of the actual treaty-text output of the various meetings of the parties; the drafters of the London Revision needed to agree upon the language of all the words in the enactment, for example, even for those passages that "merely" replaced pre-existing language.

This simple-counting approach also has some appeal as a measurement of the textual richness of the ozone treaties in another sense. A party may join any sub-set of the ozone treaties so long as that party joins the Convention and does not "skip" subsequent enactments. For example, a party may consent fully to the Convention, the Original Protocol, and the Copenhagen Revisions, but refrain from expressing any consent with respect to the later-enacted London Revisions, Nairobi Addition, Vienna
Revisions, and Montreal Revisions. Many nations have in fact fully consented to some but not all of the versions of the Protocol, as I discuss in more detail below. Each enactment, therefore, makes a permanent contribution to the possible regulations governing a potential party, even if still-later enactments override the earlier enactments for those parties joining all enactments. In terms of quantifying the variety of options presented to a nation currently unbound by any enactment, the simple-counting approach is a better measure than the composite-creation approach.
## Table Twelve

**Enactment Length and Composite Lengths of Documents in the Ozone Treaties**

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>Vienna Convention</td>
<td>1985</td>
<td>5800</td>
<td>4300</td>
<td>5800</td>
<td>4300</td>
</tr>
<tr>
<td>Montreal Protocol</td>
<td>1988</td>
<td>4400</td>
<td>4300</td>
<td>4400</td>
<td>4300</td>
</tr>
<tr>
<td>London Revisions</td>
<td>1990</td>
<td>6200</td>
<td>6000</td>
<td>7800</td>
<td>7600</td>
</tr>
<tr>
<td>Nairobi Addition</td>
<td>1991</td>
<td>100</td>
<td>0</td>
<td>7900</td>
<td>7700</td>
</tr>
<tr>
<td>(Annex D)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Copenhagen Revisions</td>
<td>1992</td>
<td>5500</td>
<td>4800</td>
<td>9900</td>
<td>9200</td>
</tr>
<tr>
<td>Vienna Revisions</td>
<td>1995</td>
<td>4200</td>
<td>1300</td>
<td>10,700</td>
<td>10,000</td>
</tr>
<tr>
<td>Montreal Revisions</td>
<td>1997</td>
<td>3400</td>
<td>1500</td>
<td>11,000</td>
<td>10,700</td>
</tr>
</tbody>
</table>

*Note: The “composite document” is the text of the Original Protocol with the changes specified by the various Revisions incorporated into a single, non-redundant document. For example, if the London Revisions provided a paragraph to replace a pre-existing paragraph in the Original Protocol, only the replacement paragraph would appear in the composite document (and thus only the replacement paragraph would count towards the length of the composite document). One might also think of the composite document as the “latest potentially governing text.”*
Table Twelve reflects both the simple-counting and the composite-creation approaches. The column headed “Length in Words of Enactment” simply counts the words in each separate “road map” of changes and additions produced by a MoP. The column headed “Length in Words of Composite Document” counts the words in the document that results from beginning with the Original Protocol and then incorporating seriatim any changes and additions resulting from the later enactments. The entry for the Copenhagen Revisions, for example, results from counting the words in the document that results from beginning with the text of the Original Protocol, incorporating the changes and additions of the London Revisions and Nairobi Addition, and then in turn incorporating the changes and additions made by the Copenhagen Revisions to the Nairobi-Addition composite document. The table also shows changes including and excluding annex text; text in the annexes is still part of the treaty, but the prevalence of chemical and numerical information in many of the annexes reduces somewhat the reliability of the counting. For example, is the phrase “0.1 - 0.4” for an ODP estimate one word or three?

Assuming for the moment that these quantifications correspond in some rough way to the output of the parties’ cooperative efforts respecting the subject matter of the ozone treaties—an assumption that I examine in more detail shortly—then what can one glean from an examination of these word counts?

The parties to the ozone-treaty regime have produced a steady flow of verbiage to guide them in their endeavor. Five of the seven two-year intervals\(^\text{182}\) from 1985–86 through 1997–1998 have led to exactly one enactment per interval. (There were two enactments in 1991–92 and none in 1993–94.) Each enactment has consisted of between 3,400 and 6,200 words. The Protocol has much more than doubled in composite length, from its initial length of 4,400 words to its current 11,000 words.

One may recall the “ratchet” effect of the breadth and depth of the regulations in the ozone-treaty regime: once included as a subject of regulation, no chemical is deregulated, and once a group is assigned an Allowable Percentage for a given year, that Allowable Percentage is never increased. It is not possible to observe a precisely analogous ratcheting with respect to the words

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182. As discussed above in connection with the MoPs, there seems to be a two-year cycle of enactment and quiescence. I therefore use two-year intervals as the relevant period. See discussion supra Part II.A.
in the treaty themselves: some phrases appearing in an enactment are later replaced. The length of both texts in the ozone-treaty regime does either increase or remain the same over time, however. The Convention has not been modified and thus remains at its original length, while the length of each composite Protocol increases steadily throughout the series.

Despite the relative steadiness of this output, one may divide the parties' linguistic products into two six-year periods surrounding the 1991-92 interval containing the Copenhagen Revisions. In the six-year period from 1985 to 1990, the parties produced a total of more than 16,000 words in the enactments constituting the Convention, the Original Protocol, and the London Revisions. In the six-year period from 1993 to 1998, in contrast, the parties produced a total of fewer than 8,000 words constituting the Nairobi Addition, the Vienna Revisions, and the Montreal Revisions.

The difference is even more dramatic if one examines the change in the length of composite documents rather than the enactments, and even if one omits the never-amended Convention and focuses on the Protocol. The Protocol grew from 0 words to 13,700 words in the period between 1985 and 1990, and then increased by only 1,100 words in the period between 1993 and 1998. (This measure omits the Copenhagen Revisions at the "pivot" in 1992.)

If one ignores not only the Convention but also the Original Protocol to focus exclusively on the Revisions, then there is a similar division between an early period of verbal proliferation and a later period of relative restraint. The Protocol was 5,600 words longer after the London Revisions, the Nairobi Addition, and the Copenhagen Revisions, while the three subsequent Revisions increased the composite length of the Protocol by only an additional 1,000 words.

The assumption that all of these quantifications of treaty length actually mean anything, of course, is subject to some doubt. Simply counting up the words in a treaty, or comparing the lengths in a series of enactments, seems more the task of a simple scrivener than ink for the wells of the analytically inclined. Certainly the connection between substance and verbal output is not to be taken for granted: one can construct prolixities of virtually no meaning, as well as profundities of great pith. The
Agreement on the Conservation of Polar Bears is roughly 1,000 words long, while the Charter of the United Nations is under 10,000 words, but one imagines that the Charter is much more than ten times as important to international politics than the Agreement (unless one is a polar bear, presumably). Indeed, the ozone-treaty set presents an example of a similar phenomenon: the 5,800 words of the Convention impose essentially no substantive obligations whatsoever on the parties thereto, while the Original Protocol uses fewer words to set forth some highly concrete obligations.

Nonetheless, one should also not be too hasty to dismiss the rough correlation between word counts and some useful measure of the output of a treaty process. In the context at hand, one is not comparing polar bears with peacekeeping, but rather one treaty addressed to the regulation of anthropogenic ozone-depleting substances with another treaty addressed to the regulation of anthropogenic ozone-depleting substances. Furthermore, once one moves away from a comparison of the Convention to the Original Protocol in favor of comparing one version of the Protocol with another, then the level of specificity evoked by the relevant obligations does seem fairly constant from document to document. One might also note that the post-Copenhagen enactments are associated not only with a diminution in the rate at which additional words are added to the Protocol but also with, as discussed earlier, a cessation in the addition of new chemicals to the groups regulated by the regime and a cessation in the further deepening of regulation (with the exception of stricter regulations for methyl bromide in both the Vienna Revisions and the Montreal Revisions).

One might also defend the usefulness of measuring the length in words of legal enactments at a more general level. Certainly, lengthier verbal formulations can be correlated with more rules or with more precisely specified rules. Academics criticized by the lay public for their wordiness or multi-syllabism frequently reply that precise speech is both necessary and necessarily lengthy. The length of treaties may similarly bear some relationship to their

184. U.N. CHARTER.
185. A counter-argument would be that those academics are simply fortifying their intellectual barriers to entry, but one might at least ponder whether such a counter-argument is as applicable to a conversation among, say, physicians or physicists as it is to a conversation among, say, professors of law or literature.
content. As with the elaboration and interpretation of rules derived from the common law or statutes or constitutions, one might argue that the interpretation of rules derived from treaties requires an increase in the length of some relevant authoritative texts, and subsequent treaty text tends to be just the repository of such clarifications in an international legal system that does not reliably produce authoritative judicial decisions.

Additionally, one must note that nations are likely to pay a price for longer texts in terms of increased transaction costs of inter- and intra-national negotiations, and that nations should be unwilling to pay that price unless the increase in length yields benefits. To negotiate longer textual passages requires, by definition, the formulation of more words, and the formulation of texts in international negotiations is rarely cost-free. The formulation of a treaty typically involves the commitment of significant governmental resources, in the form of on-site negotiators, inter-agency coordination of the national negotiating position, and (in at least some nations) interactions between the executive and legislative branches. Treaties of greater textual length seem likely to require a greater commitment of such resources. If nations are the rational, self-interested actors that IR theorists often assume them to be, then rational nations should be willing to pay the price of longer texts only if the rewards from doing so are at least commensurate.

4. Approaches

Both the breadth and the depth of the ozone treaty regulations seem to be susceptible of relatively objective measurement and to be clearly correlated to the degree of underlying international cooperation—at least so long as nations comply with those increasingly broad and deep formal obligations. As nations place more and more chemicals within the ambit of the ozone treaties' regulations, and as that regulation requires a given chemical to be consumed and produced in smaller quantities, the ozone-treaty regime clearly becomes more effective in its pursuit of a more robust ozone layer. The particular nature of the ozone-treaty regime means that the characterization of a particular change as effecting the regulation of "more and more chemicals" and "smaller and smaller quantities" thereof is a highly objective evaluation.

The length of the ozone-treaty regulations is likewise a highly objective evaluation, but the regime's verbiage does not seem so
reliably correlated with the degree of cooperation embodied in the regime. Nonetheless, given the relative ease with which one may calculate the relevant measures and given a number of arguments that do support some relationship between length and the degree of cooperation embodied in the regime, I have undertaken an examination of the length in words of the ozone treaties.

The final topic of this sub-section—the "approaches" manifested in each enactment in the set of ozone treaties—may strike some as rankly subjective. The fundamental idea is one of aggregation: to attempt to identify some higher-level approaches implicit in the myriad of particular provisions in the ozone treaties. I have already referred to the "core regulatory approach" of the ozone treaties—the aggregation of ozone-depleting chemicals into various groups with the limitation, by group, of ODP-weighted production and consumption in each year according to an Allowable Percentage of a baseline year.

One might first note that there is nothing magical, nor magically permanent, about this weighted-quota, percentage-reduction approach. Other treaties with an environmental focus have adopted, inter alia, unweighted quotas, immediate bans, quotas ranked by weight rather than by environmental harm, licenses, and admonition. Indeed, the International Convention for the Regulation of Whaling (ICRW) and the Convention on International Trade in Endangered Species have each adopted more than one of these approaches simultaneously; and the ICRW has tried but then entirely abandoned certain approaches.\(^{186}\) The fact that the core regulatory approach of the ozone treaties has remained constant throughout the various enactments following the Convention is itself noteworthy.

The core regulatory approach of the ozone treaties is not the only approach that one might identify within this set of treaties. Certainly there are provisions in the treaty on other topics. One or more of the enactments in the ozone treaties provide that richer nation-parties are required to pay 100% of the poorer nation-

\(^{186}\) With respect to quotas and bans, see International Convention for the Regulation of Whaling, Dec. 2, 1946, art. 5(1), 161 U.N.T.S. 72, 80 [hereinafter ICRW] (authorizing "regulations with respect to the conservation and utilization of whale resources, fixing [...] protected and unprotected species, ... size limits for each species, ... and catch returns"); Convention on International Trade in Endangered Species of Wild Fauna and Flora, Mar. 3, 1973, art. 2(4), 12 I.L.M. 1085, 1089 [hereinafter CITES] (forbidding parties from trading in specimens of species included in certain appendices except in accordance with various provisions).
parties' costs of compliance with the treaty,\textsuperscript{187} that each nation-party is required to ban the import of controlled substances from any non-party nation,\textsuperscript{188} and that there are multiple languages in which the text of the treaty has been translated with equal authenticity.\textsuperscript{189} Some of these provisions, or some combinations of them, seem sufficiently related and sufficiently important to rise to the level of an "approach" that one might use as a short-hand description of a significant aspect of the treaty regime. The judgment about which provisions combine to represent an "approach" is a subjective determination, but I pursue it here as a potentially fruitful way to examine both the statics and the dynamics of the enactments in the ozone treaties. 

Table Thirteen summarizes the approaches embodied in the ozone treaties. These approaches are largely cumulative—that is, an approach adopted in one treaty carries through unmodified to all later treaties, unless otherwise noted. For the sake of conciseness, therefore, Table Thirteen shows the approaches newly embodied in each of the enactments in the set of ozone treaties.

\textsuperscript{187} See London Revisions, supra note 115, art. 10, at 550-51 (establishing Multilateral Fund to enable compliance of parties operating under paragraph 1 of Article 5).

\textsuperscript{188} See Montreal Protocol, supra note 41, art. 4, at 33-34.

\textsuperscript{189} See id. art. 20, at 39.
<table>
<thead>
<tr>
<th>Enactment</th>
<th>New Approaches</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vienna Convention</td>
<td>General Cooperation</td>
</tr>
<tr>
<td></td>
<td>Scientific Cooperation</td>
</tr>
<tr>
<td></td>
<td>Procedures for Future Enactments</td>
</tr>
<tr>
<td>Montreal Protocol</td>
<td>Core Regulatory Approach</td>
</tr>
<tr>
<td></td>
<td>Exceptions to Core Regulatory Approach</td>
</tr>
<tr>
<td></td>
<td>(Industrial Rationalization for all, and Basic Domestic Needs for Developing Countries)</td>
</tr>
<tr>
<td></td>
<td>Trade Bans</td>
</tr>
<tr>
<td></td>
<td>Developing-Nation Delay</td>
</tr>
<tr>
<td>London Revisions</td>
<td>Multilateral Fund</td>
</tr>
<tr>
<td></td>
<td>{Exceptions to Core Regulatory Approach}</td>
</tr>
<tr>
<td></td>
<td>(Basic Domestic Needs for Developing Countries)</td>
</tr>
<tr>
<td>Nairobi Revisions</td>
<td>None</td>
</tr>
<tr>
<td>Copenhagen Revisions</td>
<td>{Exceptions to Core Regulatory Approach}</td>
</tr>
<tr>
<td></td>
<td>(Essential Domestic Uses for Developed Nations Once Allowable Percentage is 15 or Below)</td>
</tr>
<tr>
<td>Vienna Revisions</td>
<td>None</td>
</tr>
<tr>
<td>Montreal Revisions</td>
<td>Export Ban for Non-Complying Parties</td>
</tr>
<tr>
<td></td>
<td>Licensing for Imports and Exports</td>
</tr>
</tbody>
</table>

*Note:* The braces, {}, indicate a significant modification to an already-existing approach.
The Convention appears to involve roughly four approaches: (1) vague promises of general cooperation among nations; (2) some moderately concrete specifications of the scientific agenda (as set forth in the annexes) with respect to which the parties are to coordinate their research; (3) a set of rules governing the status of the Convention itself (such as when it enters into force, how it is to be amended, when and how parties may withdraw from it); and (4) a promise also to use those rules with respect to the texts of any future “protocols” building on the Convention. The third approach—specifying when the Convention will be partly and fully binding on nation-parties, and how to amend its text—is common to all treaties and will not be discussed further for any treaties in the ozone-treaty regime. The other approaches—a vague promise of general cooperation, the specification of a cooperative scientific agenda, and the adoption of a convention-protocol approach—are sufficiently distinct from the approaches of a large number of other treaties to keep in mind.190

It is clear that the Original Protocol adds at least four more approaches to those set forth in the Convention. The first is the core regulatory scheme, discussed in exhaustive detail above, in which parties promise to reduce their production and consumption of regulated chemicals in accordance with the Allowable Percentages specified in the treaties. The second is the specification of exceptions to this core regulatory scheme. For purposes of “industrial rationalization,” and with respect to production only (not consumption), a party may exceed its Allowable Percentage by a specified amount (typically 10%, but occasionally 15%).191 For developing countries, production for “basic domestic needs” may also contribute to the specified-percentage excess.192 The third clear addition of the Original Protocol is a promise not to engage in trade of regulated substances with nations that are not party to the Original

190. For example, the first set of strategic arms-control agreements focused on substance. “While the Ozone Convention sets forth a number of organizational and procedural rules for future agreements, the SALT I agreements make no explicit effort to lay down procedural provisions governing future treaties and specify only a bare minimum of organizational arrangements.” Setear, Iterative Perspective, supra note 13, at 224. Likewise, “[w]hile the London and Copenhagen Revisions to the Montreal Protocol make clear their huge debt to the Protocol itself, later strategic arms-control agreements rarely make explicit reference to a previous treaty in the series.” Id.

191. See Montreal Protocol, supra note 41, art. 2(5), at 32.
192. See id. art. 5(1), at 34-35.
Protocol. The fourth clear additional approach in the Original Protocol is a statement that a developing nation may delay by ten years its obligations under the core regulatory scheme of the Protocol, so long as its ODP-weighted consumption and production of controlled substances does not exceed 0.3 kilograms per capita. The Original Protocol thus adds four approaches to those of the Convention: the core regulatory scheme, exceptions to the core regulatory scheme allowing a percentage overage for industrial rationalization or (for developing nations) basic domestic needs, a ban on trade with non-parties, and a blanket ten-year delay for developing nations maintaining relatively minimal usage levels.

The London Revisions, as discussed above, significantly increase the breadth and depth of the core regulatory scheme of the Original Protocol. But for present purposes, this does not constitute a new approach. The numbers change, but the basic structure—percentage reductions for ODP-weighted groups of chemicals in comparison to a baseline year—does not.

The London Revisions do clearly adopt one new approach, however. The Original Protocol, essentially tracking the vague promises of the Convention, states that: “Taking into account in particular the needs of developing countries, [the parties shall] cooperate in promoting technical assistance to facilitate participation in and implementation of this Protocol.” The London Revisions, in contrast, bring so much specificity to the question of technical assistance, including financial transfers therefor, that one must, in my view, call it a whole new approach. The relevant assistance is so clearly to include financial assistance that the relevant article, called “Technical Assistance” in the Original Protocol, is renamed “Financial Mechanism.” That mechanism is to include a “Multilateral Fund.” The purpose of the relevant financial and technical assistance is to “meet all agreed incremental costs” of compliance with the Protocol incurred by less-developed nations. Only developed nations are obliged to contribute to the financial mechanism (although all parties are

193. See id. art. 4, at 33-34.
194. Id. art. 5(1), at 34.
195. See generally discussion supra Part II.
196. Montreal Protocol, supra note 41, art. 10(1), at 36.
197. See London Revisions, supra note 115, art. 10, at 550.
198. See id. art. 10(2), at 550.
199. See id. art. 10(1), at 550.
“encouraged” to contribute), and they are to do so in the proportions inter se already established for the assessment of UN costs generally.\(^{200}\) The London Revisions also provide some organizational details concerning the Multilateral Fund—the creation of an executive committee, the naming of some advisory bodies (e.g., the World Bank and the United Nations Environment Programme), and some voting rules.\(^{201}\)

Additionally, the London Revisions eliminate the industrial-rationalization exception to production reductions, though those Revisions leave intact the basic-domestic-needs exception for developing countries. For present purposes, I consider this to be an important modification of an already-existing approach, rather than the addition of a new approach.

Finally, the London Revisions elaborate upon the definition of “production” so as to subtract from that number both any substances destroyed (in ways approved by the parties) and any substances used entirely as “feedstock” in the manufacture of other chemicals. I do not consider this change to rise to the level either of a new approach or an important modification to an existing approach.

As with the London Revisions, the Copenhagen Revisions modify the exceptions to the core regulatory scheme: in a number of instances, exceptions for “essential domestic uses” are allowed once the Allowable Percentage for a given group of chemicals reaches 0%.\(^{202}\) (The Copenhagen Revisions also increase the breadth and depth of the core regulatory scheme, as described in more detail above, while leaving its general approach intact.)\(^{203}\)

The Vienna Revisions, as adjustments, cannot affect the approaches taken in the treaty regime. Adjustments can only change the ODPs or allowable aggregate ODP-weighted percentages of already-regulated substances, which does not constitute a change in “approach” in my terminology.\(^{204}\)

\(^{200}\) See id. art. 10(6), at 551 (stating that the Multilateral Fund shall be financed by contributions from Parties not operating under paragraph 1 of Article 5 and encouraging contributions by other Parties).

\(^{201}\) See id. art. 10(5), at 550-51 (establishing an Executive Committee “selected on the basis of a balanced representation,” to discharge its duties “with the co-operation and assistance of the [World Bank], the United Nations Environment Programme, the United Nations Development Programme or other appropriate agencies depending on their respective areas of expertise”).

\(^{202}\) See Copenhagen Revisions, supra note 109, art. 2(A-E), at 876-78.

\(^{203}\) See generally discussion supra Part II.

\(^{204}\) See Montreal Protocol, supra note 41, art. 2(9), at 32-33.
The Montreal Revisions arguably involve two new approaches. First, a new article, 4A, is added to the Protocol, which states:

1. Where, after the phase-out date applicable to it for a controlled substance, a Party is unable, despite having taken all practicable steps to comply with its obligation under the Protocol, to cease production of that substance for domestic consumption, other than for uses agreed by the Parties to be essential, it shall ban the export of used, recycled and reclaimed quantities of that substance, other than for the purpose of destruction.

2. Paragraph 1 of this Article shall apply without prejudice to the operation of Article 11 of the Convention and the non-compliance procedure developed under Article 8 of the Protocol.205

Paragraph 1 of these provisions thus obliges a party, violating its obligation to phase-out entirely a group of chemicals (except for essential uses), not to export chemicals in that group (except to have them destroyed); paragraph 2 states that the export ban applies without prejudice to the operation of the dispute resolution mechanism (DRM) or noncompliance procedure (NCP) described in more detail below. These provisions may have been drafted somewhat inartfully—the first paragraph could be read to imply that parties not having taken all practicable steps towards compliance have no obligation to ban exports—but they are intriguing nonetheless. The explicit discussion in a treaty of the permissible responses to breach of that treaty is, as mentioned above, taboo. This provision not only breaks the taboo, but attempts to impose particular obligations upon the breaching party (i.e., the export ban) rather than validating particular responses within the control of the non-breaching parties (e.g., the ability to suspend its own performance under the treaty). The imposition of additional promises upon a party, contingent upon a breach of that party’s other promises, should not look especially surprising to those familiar with liquidated-damages or acceleration clauses in domestic contracts, but such an approach in international treaties is an almost-startling innovation.206

205. Montreal Revisions, supra note 114, Annex IV art. 4A.  
206. The Montreal Revisions also set up a licensing scheme for the import and export of controlled substances. See id. Annex IV art. 4B.
In a very broad sense, the changes over time in the number of approaches embodied in the ozone treaties are consistent with the changes over time in breadth, depth, and length: an initial period of great change precedes a period of lesser change. After the first three enactments, the treaty regime embodies eight approaches; the five subsequent enactments added only two more approaches (and modified one of the pre-existing approaches).

Nonetheless, an examination of approaches yields a somewhat different perspective on the dynamics of the ozone treaties than these other measures. With respect to breadth, the increase begins only with the Montreal Protocol, continues with the London Revisions and the Copenhagen Revisions, and then ceases. With respect to depth, an evaluation aggregated across each agreement is more difficult to construct, although the picture is similar. The Montreal Protocol begins a period of a rapidly deepening regime; by the time of the Copenhagen Revisions, six of the eight regulated groups had specified 0% Allowable Percentages for some future year, though the subsequent Vienna Revisions and Montreal Revisions both continued to increase somewhat the depth of the overall regime.

With respect to length, the relevant measurement takes on a non-zero value from the beginning, with the regime at the time of the Copenhagen Revisions attaining about 90% of its current length in words.

The approaches embodied in the regime likewise begin with the Vienna Convention rather than, as with breadth and depth, in the Montreal Protocol. In contrast to the three other measurements, however, the regime appears in one sense to have matured by the time of the London Revisions rather than the later Copenhagen Revisions. Eight approaches are in place with the enactment of the London Revisions, while the Copenhagen Revisions do nothing more than modify one of the pre-existing approaches. Additionally, the number of approaches in the treaty regime not only involves an initial burst of activity that comes to a close more rapidly than in the case of breadth or depth or length, but also involves a second burst of activity with the Montreal Revisions, which added two new approaches—an export ban with respect to non-complying parties and a licensing scheme for all imports and exports. Neither length nor breadth nor depth displays such a second burst of activity.
C. Membership (Coverage)

Given the consensual nature of international legal mechanisms for effectuating cooperation, one must consider not only the breadth and depth of the rules embodied in the ozone treaties, but also the extent of membership in a treaty regime. A treaty embodying an outright ban on the production of every ozone-depleting substance known to humankind might be of relatively limited value if only one nation fully consented to that treaty. One advantage of studying treaties is that the same formalism and structure that makes the treaty process generally iterative means a good deal of data is also readily available with respect to the breadth of formal membership in the treaty regime.

I would readily admit that formal adherence can be both under- and over-inclusive as a proxy for true participation in the treaty scheme. A nation could fail to sign or ratify a treaty, yet behave in a way consistent with all of that treaty’s terms. Such a phenomenon implies a number of interesting issues, such as the balance between a nation’s reaping the favorable publicity from joining a treaty regime and that nation’s constraining its freedom of action in the future. I ignore such issues, however. Alternatively, and perhaps of greater concern, formal adherence might be an over-inclusive proxy for cooperation: a nation could agree formally to be fully bound by a treaty but violate every one of its terms. I account, at least in part, for this latter possibility in a later discussion of “compliance.”

Here, however, I simply assume that the degree of a nation’s formal adherence is a useful if imperfect proxy for its degree of cooperation with the ozone treaties, and proceed actually to examine formal national consents to the ozone treaties.

For the sake of terminological uniqueness, I call the extent of membership in a treaty regime its “coverage.” (I am tempted to refer to the “breadth” of membership, but that term, alas, is already taken in my schema.)

1. Entry

The most basic aspect of coverage, at least with respect to enactments that have entered into force, is presumably the number of nations fully bound by the enactment at issue. Table Fourteen below provides that information for the first four enactments in the ozone regime to require a separate expression of full consent: the Convention, the Original Protocol, the London Revisions, and
the Copenhagen Revisions. (The Montreal Revisions, the final document requiring a separate expression of full consent, were adopted too recently to make coverage data meaningful.) Table Fourteen expresses coverage, both as absolute numbers of nation-states fully bound and as a percentage of all nations, under two definitions of "all nations."
### TABLE FOURTEEN

**Coverage of Nations Fully Bound by Ozone Treaties as of December 31, 1998**

<table>
<thead>
<tr>
<th>Enactment</th>
<th>Number of Nations* Fully Bound</th>
<th>Percentage of Nations* fully bound (190 Nations)</th>
<th>Number of UN Members Fully Bound</th>
<th>Percentage of UN Members Fully Bound (185 Nations)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vienna Convention</td>
<td>169</td>
<td>89</td>
<td>166</td>
<td>90</td>
</tr>
<tr>
<td>Montreal Protocol</td>
<td>168</td>
<td>88</td>
<td>165</td>
<td>89</td>
</tr>
<tr>
<td>London Revisions</td>
<td>127</td>
<td>67</td>
<td>126</td>
<td>68</td>
</tr>
<tr>
<td>Copenhagen Revisions</td>
<td>87</td>
<td>46</td>
<td>86</td>
<td>46</td>
</tr>
</tbody>
</table>

* Nations are per the U.S. Department of State listing of "independent states" which defines a state as "a people politically organized into a sovereign state with a definite territory recognized as independent by the US." The list includes all members of the United Nations except the Federal Republic of Yugoslavia (which has been deprived of its seat in the UN General Assembly but has not been expelled from the United Nations). The Department of State listing includes five nations not members of the UN: the Holy See, Nauru, Switzerland, Tonga, and Tuvalu.
One might compare these figures with some other environmental treaties. As of mid-1999, there were roughly 145 nations fully bound to the Convention on International Trade in Endangered Species of Flora and Fauna (CITES), 207 roughly 90 nations fully bound to the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal, 208 and roughly 40 nations fully bound to the International Convention for the Regulation of Whaling. 209

A listing of the degree of participation of particular nations provides a useful overview with somewhat more detail. The ozone treaties are progressive in the sense that full consent to an enactment is full consent expressly or impliedly to prior enactments. (A nation need not express its full consent to the latest enactment in order to express its full consent with respect to any enactment, however, as was mentioned above in the discussion of treaty lengths.) One may therefore determine the degree of participation in the ozone-treaty regime without much difficulty. Appendix A lists the degree of participation of nations in the treaty regime respecting the same treated above in Table Fourteen.

From the point of view of evaluating the growth over time in international cooperation with a treaty regime, the fundamental formal measure is presumably the number of nations with respect to which each treaty is in force. Table Fifteen shows the cumulative number of nations with respect to which each treaty is in force at the end of each calendar year from 1988 (the year that the Convention first entered into force) through September 1999.

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207. See supra note 186. For most recent list of parties, see CITES Secretariat (last-modified July 16, 1999) <http://www.wcmc.org.uk/CITES/english/parties.htm>.


209. See id. As with the other environmental treaties discussed here, this last is not limited in its membership to any geographical or functional—i.e., whaling—sub-grouping of nations. Switzerland is a member of the whaling convention despite what one assumes is a limited history of, or direct economic interest in, whaling.
Table Fifteen

Cumulative Number of Nations Fully Bound by Each Document in the Ozone Treaty Set at the End of Each Calendar Year

<table>
<thead>
<tr>
<th>Year</th>
<th>Vienna</th>
<th>Montreal</th>
<th>London</th>
<th>Copenhagen</th>
</tr>
</thead>
<tbody>
<tr>
<td>1988</td>
<td>37</td>
<td>30</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1989</td>
<td>57</td>
<td>52</td>
<td></td>
<td></td>
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<tr>
<td>1990</td>
<td>73</td>
<td>65</td>
<td>2</td>
<td></td>
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<tr>
<td>1991</td>
<td>81</td>
<td>75</td>
<td>16</td>
<td></td>
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<tr>
<td>1992</td>
<td>103</td>
<td>98</td>
<td>43</td>
<td></td>
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<tr>
<td>1993</td>
<td>133</td>
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<td>75</td>
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<tr>
<td>1994</td>
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<td>1997</td>
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<td>163</td>
<td>117</td>
<td>74</td>
</tr>
<tr>
<td>1998</td>
<td>169</td>
<td>168</td>
<td>127</td>
<td>87</td>
</tr>
<tr>
<td>1999</td>
<td>171</td>
<td>170</td>
<td>136</td>
<td>99</td>
</tr>
</tbody>
</table>

(through Sept. 15)

Chart One presents the same data in graphical form. This presentation emphasizes the closely parallel coverage of the Convention and the Original Protocol, supporting the notion that parties have treated the Initial Enactments as a linked pair of documents after a brief period in which many nations joined the Convention but not the Original Protocol. (Thirty-seven nations were fully bound by the Convention by the end of 1988, at which point the Original Protocol had barely been adopted; eight nations were fully bound by the Convention but not the Original Protocol at the end of 1990; in 1991 the difference is six, in 1992 five, and after that the differential is never more than three nations.)
CHART ONE

NUMBER OF NATIONS FULLY BOUND BY EACH OF THE FOUR MAJOR ENACTMENTS IN THE TREATY SET
This presentation also emphasizes the dramatic growth in the coverage of the ozone regime from 1992 through 1994, with a subsequent maturation afterwards. In the space of just two years, 1993 and 1994, the coverage of the Initial Enactments increased by almost 50% over its coverage in 1992; the nations joining the Initial Enactments during those two years in fact represent more than 25% of all the nations in the world. Between its entry into force in 1992 and the end of 1994, 101 nations became fully bound by the London Revisions. With the broad coverage of the London Revisions and the entry into force in 1994 of the Copenhagen Revisions, the effective depth and breadth of the regime had also increased substantially. After 1994, one can see that the coverage of all of the first four enactments in the ozone-treaty regime grew only slowly. The Copenhagen Revisions did not garner the same burst of fully bound adherents as the London Revisions, for example: the Copenhagen Revisions had entered into force for fewer nations after four years than the London Revisions had garnered in two years. (One should note that the Copenhagen Revisions were adopted in November while the London Revisions were adopted in June; therefore the adoption of the end of the calendar year as the point of measurement places the Copenhagen Revisions at a half-year disadvantage.)

If one desires a measurement of the rate at which coverage accrues that focuses on inter-enactment comparisons, one might examine the accumulation of expressions of full consent within a particular period after the adoption of each enactment. Such a measure also places more emphasis on national intentions, rather than on the national obligations measured by entries into force. Focusing on expressions of full consent rather than on entry into force avoids the boundary effect created by the triggering entry into force (which triggers the entry into force for all nations previously expressing full consent) and thus allows an examination of pre-initial-entry-into-force activity. Table Sixteen shows the numbers of full consents accumulated for a given enactment within each 365-day period following the document’s adoption; Chart Two presents the same data in graphical form.
Table Sixteen

Cumulative Number of Nations Expressing Full Consent within Given Periods Following Adoption

<table>
<thead>
<tr>
<th>Number of 365-day periods</th>
<th>Vienna Convention</th>
<th>Montreal Protocol</th>
<th>London Revisions</th>
<th>Copenhagen Revisions</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0</td>
<td>8</td>
<td>3</td>
<td>11</td>
</tr>
<tr>
<td>2</td>
<td>8</td>
<td>46</td>
<td>28</td>
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<tr>
<td>3</td>
<td>16</td>
<td>62</td>
<td>64</td>
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<td>4</td>
<td>41</td>
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<td>126</td>
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<td>7</td>
<td>83</td>
<td>139</td>
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<tr>
<td>8</td>
<td>113</td>
<td>150</td>
<td>121</td>
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<td>9</td>
<td>136</td>
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<td>10</td>
<td>150</td>
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<tr>
<td>11</td>
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<td>12</td>
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<tr>
<td>14</td>
<td>169</td>
<td></td>
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</tr>
</tbody>
</table>
The broad message is as before: the ozone-treaty regime has steadily accumulated adherents to all of its enactments. This measurement does allow a ready comparison of one document to another, however. One may thus see somewhat more clearly the appeal of the Original Protocol: in all but three 365-day periods after its adoption, the Protocol has garnered more additional adherents than any other enactment in the comparable passage of time. The exception is the London Revisions during the third, fourth and fifth
years after its adoption (by margins of 2 nations, 16 nations, and 17 nations, respectively); this exception re-emphasizes the extraordinary popularity of the London Revisions during 1993 and 1994.

This measurement of coverage also allows one more readily to conclude that the Copenhagen Revisions are not keeping pace with earlier enactments relating to the Protocol.

2. Exit

As discussed briefly in Part One, any nation that has been bound for four years by the Convention or Protocol may release itself from its obligations under the Convention or Protocol, respectively, simply by giving notice and allowing one year to lapse from the date of the receipt of that notice by the depository.\(^{210}\) No nation has ever done so, however. This is obviously the most enthusiastic possible testament, with respect to coverage, to the strength of the endeavor's success in sustaining international cooperation.

D. Implementation and Compliance

This sub-section first examines textual changes and then assays the degree of conformity between obligations and actual behavior.

No textual changes directly respecting implementation and compliance have occurred in the treaties themselves. As mentioned briefly in Part One, however, the parties did charge themselves with the adoption of a "non-compliance procedure" at their first MoP.\(^{211}\) They failed to meet this goal however. The first MoP resulted only in a draft non-compliance procedure ("NCP"),\(^{212}\) the second MoP resulted in the provisional adoption of that draft;\(^{213}\) the third MoP identified some areas of concern to the parties regarding the provisional NCP, and delegated to an expert group to address those concerns.\(^{214}\) It was not until the fourth MoP that the parties at last adopted a final version of the NCP.\(^{215}\)

Like the arbitration rules or the rules of procedure governing the parties’ meetings, the NCP is not part of the formal text of the

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\(^{210}\) See Vienna Convention, supra note 40, art. 19, at 333.
\(^{211}\) See Montreal Protocol, supra note 41, art. 8, at 35.
\(^{212}\) See id.
\(^{213}\) See London Revisions, supra note 115.
\(^{214}\) See Nairobi Revisions, supra note 120.
\(^{215}\) See Copenhagen Revisions, supra note 109.
treaty, and its specifications state explicitly that it "shall apply without prejudice to the operation of the" dispute-resolution mechanism set forth in the Vienna Convention.216 The NCP does create an Implementation Committee with one member from each of ten nations (chosen in rotation). This Committee has met roughly twenty times.217 In the formal sense, at least, the NCP is vibrant.

The specificity and scope of the NCP on paper is an innovation in treaty compliance. First, it creates a body devoted exclusively to concerns of implementation and compliance, whereas most treaties rely on meetings of the parties to do so. Second, the report of the Implementation Committee regarding a particular allegation of non-compliance may be the basis for a decision by the parties to "call for steps to bring about full compliance with the Protocol, including measures to assist the parties’ compliance with the Protocol."218 A further "Indicative List of Measures That Might Be Taken by a Meeting of the Parties in Respect of Non-Compliance with the Protocol" (the "Indicative List"), adopted by the same MoP that adopted the final NCP, includes not only appropriate assistance but the issuing of cautions and even "[s]uspension, in accordance with the applicable rules of international law concerning the suspension of the operation of a treaty, of specific rights and privileges under the Protocol, whether or not subject to time limits."219

Parties to treaties have thought about non-compliance and, simply by specifying the conditions of compliance, have even implicitly acknowledged the possibility that non-compliance will occur. The Convention on the Law of Treaties includes provisions addressed specifically to a non-breaching party's ability legally to suspend or terminate its own treaty obligations in responses to a breach by another party;220 these provisions are presumably the "applicable rules of international law concerning the suspension of

216. See id. at Annex IV.
217. See id. at Annex IV para. 5.
218. Id. at Annex IV para. 9.
219. Id. at Annex V.
220. The Law of Treaties prescribes certain "rules of release" which revolve around the concept of material breach. With respect to multilateral treaties, material breach is necessary but not sufficient for unilateral release. In order to justify release, the material breach must also either lead all non-breaching parties to agree that their simultaneous release is appropriate, or specially affect a party seeking release only from its obligations to the breaching state, or radically affect the future performance obligations of all parties. Law of Treaties, supra note 31, art. 60(2), at 346; Setear, Responses to Breach, supra note 14, at 15-24.
the operation of a treaty” mentioned in the Indicative List.221 As a result, it is unclear exactly what new rights or procedures are contemplated by the Indicative List. But, in contrast to the general law of treaties, a treaty on a particular substantive matter rarely acknowledges this possibility explicitly. Even formally to award near-textual status to such a procedure at a meeting of parties is apparently unprecedented and has been taken by many to represent an important innovation.

One must characterize the actual operation of the implementation-oriented portions of the treaty and closely associated text as disappointing compared to the potential implicit in the text itself.

I can find no report of any instance in which any party used the dispute-resolution mechanism (“DRM”) specified in Article 11 of the Vienna Convention. Pessimists may draw their own conclusions (as they are wont to do in any case). Optimists might suggest that Article 11’s DRM is designed to resolve disputes about the correspondence between behavior and obligation only when such disputes stem from differences in the interpretation of the treaty’s meaning. On this reading, which is plausible though hardly compelled, the absence of resort to the DRM simply indicates a well-drafted treaty. Additionally, one might argue that the parallel existence of the NCP makes resort to the DRM unnecessary. Or perhaps nations have been so diligent in complying with their obligations that there is no dispute to resolve concerning compliance or non-compliance.

There is actually some support for this last proposition in the meetings of the Implementation Committee of the NCP. One looks in vain through the reports of the Implementation Committee for signs of a classic interpretive dispute. Very occasionally, a nation makes a request for treatment that seems clearly inconsistent with the text. One might think of this as an interpretive dispute, although the flavor of these discussions actually seems closer to a plea for special treatment. In any case, the vast majority of topics discussed by the Implementation Committee involve nations offering excuses for their non-compliance, rather than nations arguing that their activity is in fact consistent with the ozone treaties as those texts should properly be interpreted. Descriptively, the Implementation Committee’s activity seems much closer to the plodding development of a

221.  See Copenhagen Revisions, supra note 109, Annex V, para. C.
modus vivendi, which the compliance-oriented school would expect, than to the confrontational sturm und drang of judgment and punishment, for which the enforcement-oriented school might hope.\textsuperscript{222} The Committee notes an instance of non-compliance, and the offender states that it is already making some progress and expects to be in compliance eventually; a meeting or two later, the problem has diminished somewhat; eventually, the situation is in fact resolved.

This is the entire story in kind, but not in degree. The countries occupying the eastern portion of the European continent appear to constitute virtually all of the nations that have come in for criticism of their compliance record with respect to the substantive phase-out provisions of the treaties.\textsuperscript{223} With the exception of the Russian Federation, and to a lesser extent Latvia and Lithuania, all of these difficulties appear to have been resolved to the satisfaction of the Implementing Committee.\textsuperscript{224}

Russia presents several troubling and still-unresolved difficulties. It is a major producer of ozone-depleting substances. It has violated its obligations not only with respect to internal consumption or production, but also with respect to trade with

\textsuperscript{222}. See Chayes & Chayes, supra note 7, at 2-3 (contrasting enforcement-oriented with compliance-oriented schools); id. at 20-21 (discussing acceptable levels of non-compliance and changes over time in such levels).

\textsuperscript{223}. For example, at the seventh meeting of the Implementation Committee Under the Non-Compliance Procedure, Belarus "could not confirm . . . that [it] would be able to meet all the 1994 reduction targets for controlled substances as mandated by the Protocol." Report of the Implementation Committee Under the Non-Compliance Procedure for the Montreal Protocol on the Work of its Seventh Meeting, para. 15, UNEP/OzL.Pro/ImpCom/7/2 (Nov. 1993). The Tenth meeting of the Committee noted that the Russian Federation presented a particular problem in terms of its access to controlled substances. Report of the Implementation Committee under the Non-Compliance Procedure for the Montreal Protocol on the Work of its Tenth Meeting, para. 32, UNEP/OzL.Pro/ImpCom/10/4 (Aug. 1995). Later, the Committee noted that, beginning in 1996, Belarus would have difficulties complying with the Protocol as a result of the economic problems that were facing countries with economies in transition, Report of the Implementation Committee under the Non-Compliance Procedure for the Montreal Protocol on the Work of its Eleventh Meeting, para. 15, UNEP/OzL.Pro/ImpCom/11/1 (Nov. 1995), and foresaw non-compliance by Ukraine, id. at para. 20. These problems persist throughout the Implementation Committee reports.

other nations. Finally, Russia has a large stockpile of ozone-depleting substances, which implies that it will need either to destroy a hefty tonnage of economically valuable material or to sell those stocks in violation of its treaty obligations. The good news is that Russia is the recipient of international aid aimed specifically at addressing some of these difficulties, and that the Russians’ outward attitude, at least, is one of conciliation.

Finally, there is a set of persistent treaty violations stemming from the failure of developing nations to file the proper reports. Indeed, much of the Implementation Committee’s output consists of what one might call “literal form-alism:” reproductions of the proper reporting forms, discussions of what words should go in which box on the forms, and so on. Failures to file proper reports have diminished over time, however. One should also note that the developing nations as a group currently account for only a very small share of the global consumption or production of ozone-depleting substances. The pessimist will note that even the filing of papers is a task beyond the ability of the international legal system to compel; the optimist will note that, unless impoverished countries have succeeded in the past few years in making the clandestine production of refrigerants and flame retardants a high priority, the failure to file these forms is of fairly limited impact.

One might also take note of three factors that may not be apparent from the relatively straightforward recitation above of the (non-) activities undertaken under the DRM and the activities of the Implementation Committee under the NCP.

First, there have been no accusations of non-compliance involving any of what were once called “First World” nations—the highly developed, free-market democracies of the OECD. These are the nations that produced the lion’s share of ozone-depleting substances when the relevant problem came to light, and their current production capacities still dwarf those of other nations.

Second, all the instances of non-compliance with substantive standards by what were once called “Second World” nations, and

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225. Report of the Implementation Committee under the Non-Compliance Procedure for the Montreal Protocol on the Work of its Seventeenth Meeting, para. 25(b), (d), UNEP/OzL.Pro/ImpCom/17/3 (Apr. 1997) (noting that Russia was in non-compliance with the Protocol for 1996 and “had exported both new and reclaimed substances to, and also imported ODS from, many Parties operating under Article 5 and those Parties not operating under that Article”).

226. Most of the Implementation Committee Reports contain sections devoted to assessing compliance with the reporting requirements of Article 7 of the Protocol and the production of data thereunder. See Montreal Protocol, supra note 41, art. 7, at 35.
all the instances of non-compliance with reporting requirements by what were once called "Third World" nations, stem from voluntary reporting by those nations of their own behavior.\textsuperscript{227} The self-reporting of a violation by an accused criminal is often the subject of derision ("THE COURT: What is the defendant's occupation?—DEFENDANT: Burglar," being a classic, if possibly apocryphal, example) or pity (in the case of many confessions). The self-reporting of a violation by a previously unaccused nation seems an extraordinary testament to the power of international legal norms. The incentive-oriented analyst would note that the presence of funding to reduce non-compliance with the ozone treaties may have something to do with such self-reporting. The pessimist will wonder what violations are occurring that are not reported at all.

An ideal solution might be the devotion of hundreds of millions of dollars, rather than tens of millions, to aid aimed at monitoring compliance with the ozone treaties, along with the devotion of hundreds of millions of dollars to monitoring efforts. Even if one believes that the threat from cheating on the ozone treaties justifies these sorts of expenditures, however, there are domestic political realities with which to contend. In the United States, at least, voters typically overestimate foreign aid's percentage of the budget by roughly an order of magnitude, and only nuclear arms-control treaties have ever seen of hundreds of millions of dollars devoted to their verification.

Finally, there is at least one market-oriented indicator that the ozone treaties are having an important effect on the consumption and production of ozone-depleting substances: you can now reliably buy those substances on a "black market," and you will pay a premium of some 1000\% to do so.\textsuperscript{228} One may lament that such substances are available at all, but their high price on the black market indicates at least that some combination of reductions in the sources of supply and governmental efforts to prosecute those engaged in that market have had an impact.

\textsuperscript{227} See id.
\textsuperscript{228} See, e.g., Frederick Poole Landers, Jr., Note, The Black Market Trade in Chlorofluorocarbons: The Montreal Protocol Makes Banned Refrigerants a Hot Commodity, 26 GA. J. INT'L & COMP. L. 457, 472-73 (1997) (noting that "a 30 pound cylinder of CFCs can be purchased [from countries operating under Article 5] for less than $35, and then resold \textit{sans} excise tax for over $500 in the United States").
IV. USING THE OZONE TREATY SET TO TEST TWO THEORIES OF INTERNATIONAL RELATIONS WITH IMPLICATIONS FOR INTERNATIONAL LAW

Parts One and Two of this paper have examined the text of the ozone treaties from the iterative perspective. Earlier work adopting the iterative perspective draws upon the theory of international relations known as neoliberal Institutionalism to argue for the importance of iteration in encouraging the evolution of cooperation.\footnote{229} That earlier work argues that neoliberal Institutionalists have paid insufficient attention to the implications of their own theory by failing to operationalize the concept of “iteration” as a real-world phenomenon. That earlier work proposes the treaty process as a real-world phenomenon set against a backdrop of temporarily well-defined iterations, with clear methods of determining formal consent to schemes of international cooperation and substantive compliance.

This article has closely examined the text of a pair of related treaties—the Vienna Convention on Protection of the Ozone Layer and the Montreal Protocol on Substances That Deplete the Ozone Layer—and concluded that those documents show a thorough-going, though not theoretically maximal, concern for promoting structured iterations among the participating parties.\footnote{230}

Part Two then examined the “outputs” resulting from the “inputs” of the Convention and Original Protocol. Part Two concluded that the text and formal expressions of consent associated with the Revisions reflect the evolution over several iterations of a strongly cooperative system, and that the compliance of consenting parties with that text has been substantial, though hardly perfect. With respect to the “breadth” of chemicals regulated, the “depth” of the percentage reductions, and the length of the texts, the textual history of the ozone treaties is consistent with the evolution of a cooperative regime under a number of various interpretations of that data. The analysis of the general “approaches” taken by the ozone treaties, while relying on interpretations both more subjective and more ambiguous than those for breadth and depth and length, also strongly implies that the original enactments set in motion an iterative and cooperative process.

\footnote{229} For relevant discussion of this work and the other propositions mentioned in this paragraph, see supra text accompanying notes 14-29.

\footnote{230} See discussion supra Part One.
This Part also examines quantitative measures associated with the ozone treaty set in order to judge their consistency with certain theoretical perspectives, but the focus of this Part is otherwise quite different from the focus of Parts One and Two. The relevant theories are derived from sources in the field of international relations quite distinct from the hybrid of rational-unity-actor theory and neo-Wilsonian faith in organizations that comprises neoliberal Institutionalism. This Part instead examines one theory advanced by gimlet-eyed Realists and one theory advanced by the domestically oriented proponents of what I will call the "Liberal" school. The source of the relevant data has a narrower emphasis as well: this Part relies entirely on coverage data, though in much more detail than in section C of Part Two.

In section A of this part, I briefly describe Realist and Liberal theories of international relations. In section B and C, I examine the validity of a Liberal and a Realist hypothesis, respectively, tested against the coverage data from the ozone treaty set.

A. Realist and Liberal Theories of International Relations

The dominant theory of international relations propounded by political scientists is known as "Realism." Realists consider international relations to be a constant struggle among nations that behave as if they are rational, that have security concerns uppermost in their calculations, and that measure their gains or losses in comparison to other nations rather than against some more absolutist standard.231

It may surprise outsiders to the field of international relations (at least if they read the newspaper) to find that the school of IR theory known as Realism can simultaneously dominate the field and assume that domestic politics is irrelevant to international relations. Nations, argue the Realists, base their decisions about foreign policy on a calculation of national interest. In the Realist view, this national interest is determined by a constellation of "objective" indicators like geography, military force, economic strength, and so forth. Any nation occupying the same objective position would make the same decisions, be it a democracy or a

231. For discussions of Realism by legal academics, see Slaughter Burley, supra note 14, at 207-08, 214-17; Setear, Responses to Breach, supra note 14, at 2-4; Mearsheimer, supra note 14, at 9-12 (summarizing the main assumptions of Realism); supra text accompanying note 14 (discussing branches of IR theory).
dictatorship, else that nation would not long survive the assumedly ruthless and relativistic competition of international politics.\textsuperscript{232}

Proponents of an alternative school, whom I will call "Liberals," argue, in contrast, that the structure of domestic politics is the crucial determinant of a nation's foreign policy.\textsuperscript{233} The Liberal school places a good deal of emphasis on the "democratic peace," the idea that democracies do not fight one another in major wars even though democracies as a group are no less likely to become embroiled in conflict than other forms of government.\textsuperscript{234} The democratic peace is a contested notion, at least in part: there is a lively debate as to whether it is a correlative or causal phenomenon,\textsuperscript{235} and as to whether it is a phenomenon limited to the twentieth century.\textsuperscript{236} Nonetheless, the democratic-peace hypothesis is certainly an important strand of thought in international relations—in significant part because of the threat that it poses to black-box Realism. The democratic-peace hypothesis focuses on "peace" and "war" as the states of "cooperation" and "non-cooperation," respectively. If one moves from those categories to a consideration of international legal

\textsuperscript{232} See Hans J. Morgenthau, Politics Among Nations 6 (3d ed. 1960) (with respect to states, Realism "provides for rational discipline in action and creates that astounding continuity in foreign policy which makes American, British, or Russian foreign appear as an intelligible, rational continuum, by and large consistent within itself, regardless of the different motives, preferences, and intellectual and moral qualities of successive statesmen. A realist theory of international politics, then, will guard against two popular fallacies: the concern with motives and the concern with ideological preferences."); see also Kenneth N. Waltz, Man, the State, and War 120-23 (1959) (concluding that the effects of differing domestic regimes are overridden by the international anarchy under which all states live).

\textsuperscript{233} See Slaughter Burley, supra note 14, at 227-28 (outlining the fundamental assumptions shared by all Liberal theories of international relations, including notion that "Liberals analyze state behavior primarily as a function of the constraints placed on state actors by being embedded in domestic and transnational civil society" and that "[a]ll governments represent some segment of domestic society, whose interests are reflected in state policy") (emphasis in original).


\textsuperscript{236} See e.g., John Mearsheimer, Back to the Future: Instability in Europe After the Cold War, 15 INT'L SEC. 5, at 50-51 (1990) (arguing that because "democracies have been few in number over the past two centuries,... there have not been many cases where two democracies were in a position to fight each other").
rules, the Liberals can still put forth a theory: democracies will cooperate more effectively with one another using international legal means than those democracies will be able to cooperate with autocracies. As applied to a particular set of treaties, the theory implies that democracies are more likely to participate and to obey than are autocracies.

The Liberals often use phrases like "liberal democracies" or "free-market democracies" or "rule-of-law nations" to describe those international actors whom they believe are especially likely to cooperate effectively with one another. I will henceforth use the phrase "liberal democracy" to denote the kind of domestic governance structure that the Liberals believe leads to fewer conflicts between nations possessing this form of governance; I will denominate its antithesis the "illiberal autocracy." I discuss shortly just which nations are liberal democracies and which are illiberal autocracies.

B. Coverage and a Liberal Theory of International Legal Cooperation

The basic Liberal hypothesis implies both a formal and a behavioral prediction. Liberal democracies should be more likely than illiberal autocracies to give their formal consent to international legal methods of cooperation and actually to comply with the international legal obligations they undertake. One might actually hypothesize interactions between these two factors that lead to different predictions. Liberal democracies might worry so much about failing to comply with their obligations that they would commit themselves to fewer such obligations than the more cavalier autocracies. I do not further pursue such interactive hypotheses here, although one could easily use the data presented here to test such hypotheses. The particular interactive hypothesis

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237. Michael Doyle sees international law as adding a second source—a guarantee of respect—to democratic pacification:
Internationally, free speech and the effective communication of accurate conceptions of the political life of foreign peoples is essential to establish and preserve the understanding on which the guarantee of respect depends. In short, domestically just republics, which rest on consent, presume foreign republics to be also consensual, just, and therefore deserving of accommodation. The experience of cooperation helps engender further cooperative behavior when the consequences of state policy are unclear but (potentially) mutually beneficial.

mentioned above, at least, proves to be unsupported by the coverage data of the ozone treaties.

The analysis of the ozone treaty coverage data below focuses on the formal implications of the Liberal hypothesis, but one may also use the example of the ozone treaties to explore the substantive behavioral implications of the Liberal hypothesis in a very general way. Russia is the largest source of concern with respect to substantive non-compliance, and Russia is a relatively illiberal state by many standards. The eastern European nations that have also, as a group, presented persistent but moderate non-compliance issues are currently in transition from illiberal autocracy to liberal democracy. (At least, one hopes that the end point will be a stable, liberal democracy.) It is fair to say, as a general matter, that these eastern European nations are more liberal than Russia but less liberal than the nation-states of western Europe. The long-standing liberal democracies of western Europe appear to have a spotless record of compliance. In rough outline and limited to a consideration of the European continent (plus the Asian portion of Russia), therefore, these broad conclusions about compliance with the ozone treaties—persistent and significant difficulties with Russia, persistent but less important problems with eastern European nations, and apparently no problems with western European nations—are consistent with the Liberal hypothesis.

These judgments about compliance or non-compliance rely, as mentioned in Part Two, on self-reporting by the parties. One may justly be skeptical about the accuracy of self-reporting: it would be rare in domestic criminal law, for example, for the prosecutor to rely almost entirely on information provided by the accused. In the context of evaluating the Liberal hypothesis, however, the self-reporting aspect of the ozone treaties is actually a useful feature, at least on the particular facts as they have developed. Democracies are typically thought to be worse at lying than autocracies. The Soviet Union, for example, radically underreported its catch under the International Convention for the Regulation of Whaling and did so with sufficient aplomb that the underreporting came to light only under the successor Russian regime. Politically significant segments of the U.S. populace long

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238. See supra Tables Seventeen through Nineteen.
239. See Montreal Protocol, supra note 41, art. 7, at 35.
suspected the Soviets of surreptitiously cheating on its arms-control agreements.\textsuperscript{241} If liberal democracies are in fact worse liars than illiberal autocracies or transitional governments, then the fact that only illiberal or transitional states have actually self-reported any treaty violations should give one great confidence that the liberal democracies are (more) compliant than illiberal states.\textsuperscript{242}

This sub-section will say no more about compliance. The focus of the remainder of the sub-section will be whether liberal democracies are in fact more likely to \textit{join} the regime, and to consent to more extensive obligations within the regime. Such an inquiry of course requires a means of determining which nations are liberal democracies and which nations are illiberal autocracies. Theoretical discussions may employ general descriptions such as "a liberal nation has democratic multi-party elections and a market-oriented economy," but the more concrete analysis of this sub-section requires an actual categorization of all the nations of the world into some set of relevant categories. Because this is intended as a paper about the ozone treaties rather than a paper about what distinguishes a liberal democracy from an illiberal autocracy, I simply adopt Freedom House's related categorizations of nations as "free," "partly free," and "not free."\textsuperscript{243} In the 1998-1999 rankings, this tripartite scheme yielded 87 free nations, 53 partly free nations, and 50 nations that are not even partly free.\textsuperscript{244} I treat this scheme as equivalent to dividing the nations of the world into "liberal democracies," "governments possessing a mixture of the characteristics of liberal democracies and illiberal autocracies," and "illiberal autocracies," respectively. I call this characteristic "governmental structure" or "degree of liberalism." Appendix B reproduces the Freedom House lists.

\textsuperscript{241} See, e.g., \textit{Arms Control: Negotiations but No Accords}, XLI CONG. Q. ALMANAC 175, 177 (1985) (reporting Reagan administration charges of Soviet violations of SALT II and other arms control agreements).

\textsuperscript{242} One might note an alternative explanation, which is that the Liberal states are actually in compliance but are self-reporting violations in order to obtain international funding for clean-up and recycling efforts. The Liberal states might, then, in actuality, be no more compliant than the illiberal states, although the Liberal states under this explanation are still compliant in an absolute sense.

\textsuperscript{243} Freedom House is an organization founded in 1941 by the evocatively non-partisan pairing of Eleanor Roosevelt and Wendell Wilkie, and its ratings of the degrees of political and civil freedoms actually accorded by a country to its citizens have been used previously by political scientists publishing in the leading political-science journal concerned with international institutions.

\textsuperscript{244} See supra Tables Fifteen through Seventeen.
The next step is to compare each nation's degree of liberalism, using the categorizations listed above, with the degree to which that nation has formally consented to be bound by the rules of the ozone treaties. The relevant data on this latter phenomenon is contained in Appendix A (Part Two's discussion of coverage also dealt with the information contained in Appendix A). That appendix shows the degree of participation in the treaty regime according to the number of major enactments joined by a nation (but omits the 1997 enactments as too recent to allow a meaningful treatment of formal consents to be fully bound).

A wholly dichotomous evaluation of the Liberal hypothesis involves comparing those "non-participating" nations joining none of the enactments in the ozone treaty set with those "participating" nations joining one or more enactments. The latter group is, after all, using "international law" to govern its relations concerning the consumption, production, and trading of ozone-depleting substances, while the non-participating group is not using any international law—or at least not using the only directly relevant rules of international law about ozone-depleting substances to which anyone pays any attention—to govern its international relations on this subject. Table Seventeen shows the composition, by degrees of liberalism, of these two groups of nations. Table Eighteen recasts data from Table Seventeen in various percentage forms.
### TABLE SEVENTEEN

**NUMBER OF NATIONS BY DEGREE OF LIBERALISM AND PARTICIPATION IN OZONE TREATY REGIME**

<table>
<thead>
<tr>
<th></th>
<th>Joining Zero Enactments (22 rated nations)</th>
<th>Joining One or More Enactments (168 rated nations)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not free (50)</td>
<td>9</td>
<td>41</td>
</tr>
<tr>
<td>Partly free (53)</td>
<td>7</td>
<td>46</td>
</tr>
<tr>
<td>Free (87)</td>
<td>6</td>
<td>81</td>
</tr>
</tbody>
</table>

*Note: Members of the European Community are counted as individual nation-states.*

### TABLE EIGHTEEN

**PERCENTAGES RELATING TO NUMBER OF NATIONS BY DEGREE OF LIBERALISM AND PARTICIPATION IN OZONE TREATY REGIME**

<table>
<thead>
<tr>
<th></th>
<th>Percentage of Nations of a Given Governmental Structure (e.g., Not Free)</th>
<th>Percentage of Those Nations Joining Zero Enactments (22 nations) that Are of Each Governmental Structure</th>
<th>Percentage of All Those Nations Joining One or More Enactments (168 nations) that Are of Each Governmental Structure</th>
<th>Percentage of All Nations (190) that Are of Each Governmental Structure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not Free (50 Nations)</td>
<td>18% (9 of 50)</td>
<td>41% (9 of 22)</td>
<td>22% (41 of 168)</td>
<td>26% (50 of 190)</td>
</tr>
<tr>
<td>Partly Free (53 Nations)</td>
<td>13% (7 of 53)</td>
<td>32% (7 of 22)</td>
<td>24% (46 of 168)</td>
<td>28% (53 of 190)</td>
</tr>
<tr>
<td>Free (87 Nations)</td>
<td>7% (6 of 87)</td>
<td>27% (6 of 22)</td>
<td>43% (81 of 168)</td>
<td>46% (87 of 190)</td>
</tr>
</tbody>
</table>
Table Eighteen is generally consistent with the Liberal hypothesis. As shown in the left-most column of percentages, 18% of all illiberal autocracies have joined no enactments in the ozone treaty set, while only 7% of all liberal democracies have elected not to participate. An intermediate 13% of all internationally liberal “partly free” nations have joined none of the ozone treaty enactments.

The three right-most columns in Table Eighteen take the degree of participation as most salient and examine the distribution of degrees of liberalism between the sets, respectively, of non-participating and participating nations. Forty-one percent of all non-participating nations are illiberal autocracies, even though, as the right-most column shows, the illiberal autocracies constitute only 26% of the universe of nations. Liberal democracies comprise only 27% of the non-participating nations even though they represent 46% of all nations. The partly free nations are intermediate in all respects: they represent 32% of non-participants, 24% of participants, and 28% of all nations. In this particular set of data, the partly free nations are in effect the fulcrum on which the other nations see-saw depending on whether one is examining participation or non-participation.

The analysis of coverage and form of government has thus far bifurcated the participation variable into nations joining no enactments and nations joining any enactments. As discussed in more detail in Part Two, however, the ozone treaty set includes a whole series of enactments, and thus “participation” need not be treated as a unitary alternative to “non-participation.” As also discussed in more detail in Part Two, each enactment in the series of ozone treaties involves regulation that is broader or deeper (or both) than earlier enactments. Nations joining a later enactment thereby join all earlier enactments as a matter of either practicality or explicit legal duty.

Viewed through the lens of the Liberal hypothesis, one might see in such a scheme an opportunity to test further the relationship between domestic governmental structure and international legal participation. Liberal democracies, for example, should have the strongest tendency to join not merely some enactment in the ozone treaty set but the strongest tendency of any governmental structure to join all enactments; illiberal autocracies which participate at all are presumably more likely to join the least restrictive enactment than the most restrictive; and so forth.
**TABLE NINETEEN**

BREAKDOWN OF "NOT FREE," "PARTLY FREE," AND "FREE" NATIONS FOR ALL DEGREES OF PARTICIPATION BY NUMBERS OF NATIONS

<table>
<thead>
<tr>
<th></th>
<th>Joined 0 Documents in Set (22)</th>
<th>Joined 1 Document in Set (1)</th>
<th>Joined 2 Documents in Set (41)</th>
<th>Joined 3 Documents in Set (40)</th>
<th>Joined 4 Documents in Set (72)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not Free</td>
<td>9</td>
<td>1</td>
<td>14</td>
<td>14</td>
<td>13</td>
</tr>
<tr>
<td>Partly Free</td>
<td>7</td>
<td>0</td>
<td>12</td>
<td>14</td>
<td>19</td>
</tr>
<tr>
<td>Free</td>
<td>6</td>
<td>0</td>
<td>15</td>
<td>12</td>
<td>54</td>
</tr>
</tbody>
</table>

**TABLE TWENTY**

PERCENTAGE OF NATIONS BY GOVERNANCE STRUCTURE WITHIN EACH DEGREE OF PARTICIPATION

<table>
<thead>
<tr>
<th></th>
<th>Joined 0 Documents in Set (22)</th>
<th>Joined 1 Document in Set (1)</th>
<th>Joined 2 Documents in Set (41)</th>
<th>Joined 3 Documents in Set (40)</th>
<th>Joined 4 Documents in Set (72)</th>
<th>As a percentage of all 190 ranked nations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not Free</td>
<td>41%</td>
<td>100%</td>
<td>34%</td>
<td>35%</td>
<td>15%</td>
<td>26% (50 of 190)</td>
</tr>
<tr>
<td>Partly Free</td>
<td>32%</td>
<td>0%</td>
<td>29%</td>
<td>35%</td>
<td>22%</td>
<td>28% (53 of 190)</td>
</tr>
<tr>
<td>Free</td>
<td>27%</td>
<td>0%</td>
<td>37%</td>
<td>30%</td>
<td>63%</td>
<td>46% (81 of 190)</td>
</tr>
</tbody>
</table>

*Note:* Column headings indicate number of documents joined and then, in parenthesis, the number of nations joining exactly that number of documents. For example, of the twenty-two nations that are not party to any of the documents in the ozone treaty set, 41% are rated in the "not free" category, while 32% fall into the "partly free" category and 27% are considered "free" nations.
Table Twenty shows the distribution of participation in the ozone treaty set by degree of liberalism and degree of participation. These data are quite consistent with the hypothesis that liberal nations are more likely than their illiberal counterparts to consent to more enactments in the series, although here, as elsewhere, I do not present any test of statistical significance. Fifty-four liberal democracies have joined all four enactments, while only 33 liberal states are scattered among the four lesser degrees of participation. The greatest possible degree of participation is thus both the most frequent (modal) and the central (median) level of participation by liberal democracies. "Partly free" nations distribute themselves almost evenly across the two-enactment, three-enactment, and four-enactment participants (12, 14, and 19, respectively), with three-enactment participation the median (but not the mode) for this group of intermediately liberal nations. "Not free" nations are likely in nearly identical proportions to participate in two, three or four enactments. Advocates of the Liberal hypothesis might have hoped that non-participation (or participation in only one enactment) would be the most common choice for illiberal autocracies, but participation by this group is still more limited than the typical degree of participation by more liberal nations.

The differences are perhaps a bit more striking if one examines the composition by governmental structure of each level of participation. See Table Twenty. Of the nations bound by none of the four major enactments in the ozone treaty set, just under 40% are in the "not free" category, while only 15% of those bound by all of the four major enactments are "not free" nations. The "free" nations are conversely—though not inevitably, owing to the presence of the third, "partly free" group—the smallest percentage of the no-participation group (27%) and the largest percentage of the maximal-participation group (63%). The two-enactment and three-enactment participators are both divided almost equally among free, partly free, and not free nations. Indeed, the only numbers inconsistent with a qualitatively perfect relationship between degree of liberalism and degree of participation are the slight dip in the number of participating free nations as one moves from the two-enactment level to the three-enactment level and the very slight rise in not-free participation from the two-enactment to the three-enactment categories.

I hasten to add that a variety of alternative explanations are of course possible for the apparently positive correlation between a
nation's degree of political liberalism and the extent of its participation in the ozone treaty set. Perhaps wealth is the true determinant of participation in the ozone treaties, and a correlation between liberalism and wealth results in the correlation between liberalism and participation even though liberalism is not truly the cause of the correlation. More elaborately, a relationship between liberalism and wealth, and between wealth and a "taste for environmentalism" might be the true cause of the correlation between liberalism and participation in an international environmental regime. Political liberalism might even be correlated with a nation's distance from the equator; liberal nations would then, in the particular treaties at issue here, have a greater incentive to minimize ozone depletion, owing to the generally greater vulnerability of non-equatorial populations to the effects of ozone depletion owing to various factors of atmospheric chemistry and human biology. One might explore these alternatives with the aid of various data on national characteristics, but I do not explore such alternatives here. I aim simply to show that, if one takes the Liberal hypothesis seriously, then the coverage data of the ozone treaties at least appear to be consistent with that hypothesis taken on its own terms.

C. Coverage and a Realist Theory of International Legal Cooperation

This section of Part Three examines a hypothesis drawn from the theoretical perspective of IR Realists rather than IR Liberals. The Realists are never at a loss for words in describing the implications of their theory for international law, and they almost invariably use the same words in describing those implications: international law is irrelevant. Typically, this assertion is buttressed by examples of how nations have in fact violated their international legal obligations. (The inter-war Kellogg-Briand

245. The nations with territory at or north of 60 degrees North latitude are (from the Greenwich meridian eastwards) Great Britain, Norway, Sweden, Finland, Russia, the United States, Canada, Greenland (Denmark), and Iceland. Their 1998-99 Freedom House ratings are, respectively, free, free, free, free, partly free, free, free, free, and free. See <http://www.freedomhouse.org/rankings.pdf>. Nations with territory at the equator, excluding Pacific micro-states, are (from Greenwich meridian eastwards) Gabon, Congo, Democratic Republic of Congo ex Zaire, Uganda, Kenya, Somalia, Indonesia, Ecuador, Columbia, and Brazil. Their 1998-99 Freedom House ratings are, respectively, partly free, not free, not free, partly free, not free, partly free, free, partly free, and partly free. See id.; see also JARED DIAMONDS, GUNS, GERMS, AND STEEL: THE FATES OF HUMAN SOCIETIES 14, 25 (1997) (arguing that geography and biogeography explain differential success of peoples).
Pact of 1928, renouncing war as an instrument of international policy, is a favored example of those who also frequently criticize their opponents as incapable of moving beyond the Wilsonian era.) Faced with some scattered evidence that nations actually obey their international legal obligations, however, one trio of Realists recently decided to elaborate upon the effective meaning of "irrelevant": in their view, it is now possible that a nation will comply with its international legal obligations, but only because those obligations will be perfectly consistent with behavior it would have undertaken in any event.246

In one sense, this elaborated theory is impervious to empirical disproof. The world as it exists includes international law, and it is not possible to formulate an experiment in which the world is otherwise the same but entirely lacks international law. It is thus impossible to present the proponents of the elaborated Realist view with a pair of situations disproving their assertion by showing that, in one version of world history, a nation takes a set of actions X that is consistent with international law while, in another version of world history, that nation takes a set of different actions Y in the absence of international law. One might try something similar: one might take a pair of nations similarly situated, except that only one of them has formally bound itself to an international legal rule, and then see if their behaviors differ. I leave the construction of such pairs to others. (No one who has been anywhere near the Fourteenth Amendment can be sanguine about satisfying the requirement that two entities be "similarly situated"—except for the additional requirement of possessing different international legal obligations—when one has fewer than 200 entities, i.e. nation-states, from which to choose, especially in light of the Realists' tenacity in defending their theories against assertions of inconsistency with empirical evidence.) Instead, I recast the elaborated Realist hypothesis into one of two falsifiable variations, and then examine the consistency of the coverage data on the ozone treaties with those two variant hypotheses.

One variant of the elaborated Realist hypothesis—the irrelevance of international law—would hold that there should be no correlation between the strictness of international legal obligations and the propensity of nations to consent formally to

such obligations.\textsuperscript{247} If international law is irrelevant, in other words, one assumes that the rational, unitary nation-state (an assumption about the nation-state commonly made by both Realists and neoliberal Institutionalists) undertakes international legal obligations for some reason besides any intention or duty to perform them. If international legal obligations are irrelevant, in other words, then one should observe an essentially random distribution of consents across the strictness of those obligations. (As ever, domestic political structures remain irrelevant to Realists, so I do not examine such structures in this section of Part Three, even though the form of domestic political governance was the crucial determinant of formal and substantive adherence to international legal obligations in the Liberal hypothesis evaluated in the previous section of Part Three.)

The coverage data from the venerable Appendix A, previously discussed in connection with section A of this Part, do not seem particularly consistent with this random-distribution hypothesis—although, as before, I perform no tests of statistical significance. Only 22 nations have elected not to participate, while 167 chose to undertake some obligations from among those offered by the ozone treaties. One would need to move 72 nations (more than a third of the total) from the participating to the non-participating category to reflect a 50-50 split.

Perhaps, however, this is the improper dimension along which to expect randomness. Because the elaborated Realist hypothesis focuses on nations that do formally consent to international legal obligations,\textsuperscript{248} one might wish to examine only those nations participating in the ozone treaty set. Unfortunately for the viability of this variant of the hypothesis, however, the distribution within those undertaking at least some obligations also appears to be far from random. One nation occupies the first category; 41 occupy the second category; 40 the third category; and 86 nations the fourth category. An even division of the 168 participating nations among the four categories would have produced a number \((168/4 = 42)\) quite similar to that actually observed with respect to two of the categories, but the "1" and "86" data points are rather distant from the value of "42" that would be observed in all categories under the perfectly even division among degrees of

\textsuperscript{247} See id. at 387.
\textsuperscript{248} See id. at 387-99.
participation implied by the random-distribution version of the elaborated Realist hypothesis.

A second variant of the elaborated Realist hypothesis would be to assume that nations are in fact going to behave as they would in the absence of international legal obligations, but that nations assume that not every actor in the system shares this belief. One might compare this to a "gullible-public hypothesis" about international law: political leaders governing a gullible populace will find it in their interest to join substantively meaningless international legal agreements because their populace gives them some credit for doing so. This particular hypothesis is *verboten* for the Realist, however, so long as he or she maintains that domestic politics is irrelevant to international relations. It would, after all, be only a short step from such a hypothesis to the assertion that public opinion matters, even in the face objective factors. But one could maintain this hypothesis, while preserving the Realists' focus on objective factors, by assuming that the gullible actors in question are other nation-states rather than the domestic *polis*.249

This variant of the elaborated Realist hypothesis appears much more consistent with the ozone treaty coverage data than does the random-distribution variant. The coverage data appears to show a bias toward higher levels of participation. There are, as mentioned just above in connection with the random-distribution variant, 22 nations abstaining entirely from participation in the ozone-treaty regime in contrast to 168 participating in some form; the ratio of participants to non-participants thus exceeds 7:1. Among participating nations, the number of participating nations in the levels from least to most participatory reads: 1, 41, 40, and 72. A bias towards taking on more extensive obligations thus appears to exist whether one examines the difference between non-participation and participation, or the difference among degrees of obligation.

One might note three broader points before concluding this discussion of Realist hypotheses.

The first two of these points flow from the *actual* hypothesis of elaborated Realism, which is that variations in degrees of participation exactly reflect how nations intended to behave in the absence of international legal obligation.250 Applied to the ozone

249. There are then some problems with the systemic consistency of every nation's thinking that other nations are gullible, but I ignore these difficulties.
treaties, the actual hypothesis of elaborated Realism is thus that, for reasons independent of the enshrinement or not of any behavior in the text of the ozone treaties, 22 nations intend to behave inconsistently with the ozone treaties (and thus do not join), 1 nation intends to undertake some vague cooperation regarding scientific research, 41 nations intend to produce levels of ozone-depleting substances consistent with the Original Protocol, 40 nations intend to produce fewer ozone-depleting substances as set forth in the London Revisions, and 72 nations intend to produce the still-smaller quantities of ozone-depleting substances consistent with the Copenhagen Revisions.

First, to reiterate in a specific context a point made earlier in a general sense, there is no possible configuration of observed participations that would lead the proponents of elaborated Realism to change any of their conclusions one whit. Their impressively versatile answer would still be that the (new) configuration reflects exactly what nations would have done in the absence of the enshrinement of those obligations in an international legal format.

Second, there is actually a sense in which the elaborated Realist view implies an extremely important role for international law. If nations undertake exactly those legal obligations consistent with the behavior that they intend to undertake regardless of whether the obligations are enshrined in international law, and nations do actually sometimes undertake obligations, then one may use international law as an absolutely reliable predictor of international behavior. Every nation undertaking an international legal obligation will reliably comply with the obligations stated therein—not out of a sense of obligation, in the Realist view, but because the nation would not have consented in the first place to the obligation unless it knew that it could easily comply. The existence of a variety of degrees of legal obligation, as set forth in the different enactments of the ozone treaties, improves the utility of this basis for prediction: one may know that both France and Italy will behave in a way consistent with the relative rigors of the Copenhagen Revisions, while a modestly defiant Monaco can be counted on to behave in accordance only with the less restrictive London Revisions. (And one must ponder whether San Marino, which has joined none of the ozone treaties, harbors plans to destroy the ozone layer single-handedly.)

Finally, one might infer from the fact that one may reasonably derive two rather different hypotheses from the elaborated Realist
position—that the distribution of nations across levels of obligation will be random, or that it will be positively correlated with degree of obligation owing to the gullibility of some actors—that the underlying theory is not very well defined. It may be unfair, however, to require a new theory also to produce unique implications.

V. CONCLUSION

The introductory material in this article briefly acquainted the reader with a variety of hypotheses attempting to explain the perceived success of international cooperative efforts to preserve the ozone layer. Part One adopted a theoretical perspective not previously applied to the ozone regime—the iterative perspective—and examined the first two international legal enactments associated with those cooperative efforts, the Vienna Convention on Protection of the Ozone Layer and the Montreal Protocol on Substances That Deplete the Ozone Layer. Part Two took as a given the international legal "inputs" of those first two treaties and examined in detail the "outputs" flowing from them—that is, the series of international legal enactments that built upon the basic materials provided by the procedural rules of the Vienna Convention and the substantive approach of the Montreal Protocol. Those outputs display a nearly uniform trend towards increasing cooperation across a wide variety of measures: the number of covered chemicals, the strictness of the rules governing covered chemicals, the number of nations joining the various enactments, the textual length of the enactments, their general approaches, and so forth. Part Three focused on which nations have joined which enactments in the series of international legal rules governing the production and consumption of ozone-depleting substances as a way of attempting to test two non-iterative theories of international relations, one growing out of Realist concerns and the other out of a Liberal perspective.

At one level, the article is an exercise in comparing various theoretical perspectives to the (textual) evidence provided by international cooperative efforts aimed at protecting the ozone layer. Parts One and Two focus on the iterative perspective derived from the IR theory of Institutionalism, while Part Three focuses on theories derived from the other two long-standing schools of IR theory, Realism and Liberalism. Parts One and Two provide significant, though hardly dispositive, support for the
iterative perspective: the initial enactments in the series of treaties governing the production and consumption of ozone-depleting substances are more thorough-goingly iterative in their construction than is the typical treaty, and the subsequent enactments built upon those initial enactments display actual cooperation across a wide variety of indicia. Part Three looks at a much narrower range of outputs of the ozone regime and concludes, in what must therefore be in an even less dispositive fashion than in earlier parts, that the ozone regime provides some support for a prediction derived from Liberal theory and little support for predictions wrested from a Realist theory. In the theoretical coliseum, therefore, this article about international law should provide a good deal of encouragement to the backers of Institutionalist gladiators, some comfort to those who cheer on Liberalism, and modest discouragement to Realists.

Academia being what it is, however, the author of an interdisciplinary article is wise also to consider separately the various disciplinary perspectives that one might take concerning the handiwork in question.

To those schooled in domestic law, this article should tell a story of international law familiar in its strangeness. There are scores of relevant parties, not the dyad of parties present in classical litigation. In fact, there is no litigation at all. Those processes of dispute resolution that we do observe are about as formally coercive as a cotillion. Absent from the cast of the ozone treaties are not only litigants and judges but also arbitrators, police, legislators, and independent administrators. Indeed, with the exception of the shells of the MoP, CoP, and secretariat, the parties to the agreements themselves are the only relevant actors. Those parties, of course, are exclusively national governments—although private organizations do play a significant role despite their minimal formal rights.

Regardless of the systematic absence of the ingredients that one might hasten to advance as the recipe for effective domestic law, the ozone treaties seem a rousing success to almost all observers. Those trained in international law are presumably pleased but not astonished. The asserted power of formalized consent mechanisms and textual formulations of facially neutral standards appears especially manifest in the case of the ozone treaties. The advantages of the convention-protocol approach, a relatively traditional but still dynamic explanation of international legal
success, also appear to have made their mark on the ozone-treaty regime.

The extraordinary success of the ozone treaties may imply a need for new explanations, however, and I have here advanced the iterative perspective as a theoretically grounded, dynamic framework that predicts the special success of the ozone treaties as a result of their special concern for promoting iterations. The treaty process is in this view not simply a substitute for substantive rigor but the very mechanism by which that rigor may occur. The Initial Enactments display a thorough-going concern for iteration, and the subsequent enactments show objective gains, across a wide variety of quantifiable measures, in the rigor of the relevant rules of international law.

To the analyst of international relations, efforts to predict the differential success of international institutions is a time-honored pursuit. To those political scientists schooled in neo-Liberal Institutionalism, the general notion that iteration plays a role in international cooperation is also familiar. Playing out the implications of the IPD not merely as a general metaphor but instead as a powerful explanation of institutional success, however, is an innovation from the perspective of either lawyers or political scientists. From either perspective, the careful mining of legal texts for quantitative indicia of cooperation is also distinctive.

To the student of organizations, and thus perhaps also to those studying law or international relations or the two together, the specific focus in this article on the ozone-treaty regime implies a number of general hypotheses about international cooperation effected through international institutions with a legal specification of their rules:

- The ozone treaties involved an initial, substantively vague agreement (the Convention) followed by a concrete agreement (the Original Protocol) that set forth one core regulatory approach—a series of percentage reductions, equal for all nations, from a baseline year in harm-weighted emissions. Subsequent enactments continued to employ this regulatory approach while broadening greatly the variety of chemicals covered and increasing substantially the percentage reductions. Is this sort of nearly immediate, persistent focus on a single regulatory approach a prerequisite for success in international institutions?
• The parties reformed or expanded the Montreal Protocol every other year with almost clockwork regularity. Is this period and persistence of textual reform a prerequisite to success in international institutions?

• The Allowable Percentage of ozone-depleting substances has become 0 in virtually every case, though an immediate ban was never attempted with respect to any substance. Is there commonly a momentum towards bans in international institutions, and if so, does it have the same temporal profile generally observed in the ozone treaties?

• The parties first put in place the most formalistically oriented provisions (such as voting rules), then the substantive regulations, then the enforcement-oriented provisions. Is this the only order that leads to successful international agreements?

• The treaty bound the richest nations to its relevant regulations immediately, while giving a substantial grace period and a 100% subsidy to poorer nations; the former communist states in Eurasia have been informally given a grace period, though one apparently measured against the actual strictures of the treaty. Is this set of bargains common in successful international institutions?

Finally, one may consider this article from the perspective of a discipline not so far expressly considered: history. The close analysis of the texts of the ozone-treaty regime and its members can serve as a sort of institutional history in what has been a little more than a decade since its inception—hardly the tenure of the Roman Empire, but still long enough for a little perspective. The history is not one of personality, but of text and of the interactions of the multiple bureaucracies constituting national governments, corporations, and non-governmental organizations.

The long view often engendered by an historical perspective might also readily lead one to emphasize that much of the story regarding the presumed purpose behind the ozone-treaty regime has yet to unfold. The ozone treaties appear to be a success in terms of the preventive promises that nation-states have made. Nonetheless, the long residence times of ozone-depleting substances and the damage already done mean that the fate of the ozone layer is yet to be determined. The Antarctic ozone “hole,” as well as non-polar radiation exposures, both appear still to be
increasing.\textsuperscript{251} Restorative efforts, beyond reducing current emissions and waiting, are in their infancy. The operation may yet be a success while the patient dies.

The historical perspective, at least as typically practiced by sophisticated historians in the (post-)modern era, also emphasizes multi-causal explanations for historical events. Economic determinism, the influence of the "great man," national destinies, technological progress—all are unfashionable, and perhaps even in the long run indefensible, in their mono-causal locus. This piece began with a survey of the wide variety of causal factors that analysts of the ozone-treaty regime, especially political scientists, have advanced in their efforts to generate "the" explanation for the success of the ozone-treaty regime in effecting international cooperation. The iterative perspective has something new to offer against the backdrop of this existing literature, but the modern-day historian might caution that there is room for many, perhaps interlocking, causes of the success of a complex international institution like the ozone-treaty regime. Just as no one chemical or sphere of human activity is responsible for generating the substances that deplete the ozone layer, there may never be just one satisfactory explanation for the progress made in a dozen years of attempts to limit anthropogenic emissions of ozone-depleting substances.

APPENDICES

I. NATIONS LISTED BY DEGREE OF PARTICIPATION IN OZONE TREATY SET

NATIONS PARTICIPATING IN NO ENACTMENTS
(22 NATIONS)

Afghanistan  Afghanistan
Albania  Haiti
Andorra  Iraq
Angola  Kyrgyzstan
Armenia  Nauru
Bhutan  Oman
Cambodia  Palau
Cape Verde  Rwanda
Djibouti  San Marino
Eritrea  Sao Tome and Principe
Guinea-Bissau  Sierra Leone

NATIONS PARTICIPATING IN EXACTLY ONE ENACTMENT
(1 NATION)

Equatorial Guinea
NATIONS PARTICIPATING IN EXACTLY TWO ENACTMENTS
(41 NATIONS)

Benin
Bosnia and Herzegovina
Brunei
Bulgaria
Burundi
Central African Republic
Chad
Dominican Republic
El Salvador
Estonia
Ethiopia
Gabon
Georgia
Guatemala
Guyana
Honduras
Kazakhstan
Kiribati
Laos
Lesotho
Libya

Madagascar
Mauritania
Micronesia
Moldova
Nicaragua
Nigeria
North Korea
St. Lucia
Solomon Islands
Sudan
Suriname
Swaziland
Syria
Tonga
Trinidad and Tobago
Tuvalu
United Arab Emirates
Western Samoa
Yemen
Yugoslavia

NATIONS PARTICIPATING IN EXACTLY THREE ENACTMENTS
(40 NATIONS)

Algeria
Bahrain
Bangladesh
Belarus
China
Comoros
Congo (Brazzaville)
Cote d'Ivoire
Cyprus
Dominica
Fiji
Gambia
Ghana
Grenada
Guinea
India
Lebanon
Maldives
Mali
Malta

Monaco
Myanmar [Burma]
Namibia
Nepal
Niger
Papua New Guinea
Paraguay
Peru
Philippines
Romania
Russia
Senegal
Singapore
South Africa
Tajikistan
Tanzania
Turkmenistan
Uganda
Ukraine
Zambia
<table>
<thead>
<tr>
<th>Nations Participating in Exactly Four Enactments (86 Nations)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Antigua and Barbuda</td>
</tr>
<tr>
<td>Argentina</td>
</tr>
<tr>
<td>Australia</td>
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<tr>
<td>Austria</td>
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<tr>
<td>Azerbaijan</td>
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<tr>
<td>Bahamas</td>
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<td>Barbados</td>
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<tr>
<td>Belgium</td>
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<tr>
<td>Belize</td>
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<tr>
<td>Bolivia</td>
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<tr>
<td>Brazil</td>
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<tr>
<td>Botswana</td>
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<tr>
<td>Burkina Faso</td>
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<tr>
<td>Cameroon</td>
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<tr>
<td>Canada</td>
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<tr>
<td>Chile</td>
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<tr>
<td>Colombia</td>
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<tr>
<td>Congo (Kinshasa)</td>
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<tr>
<td>Costa Rica</td>
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<tr>
<td>Cuba</td>
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<tr>
<td>Croatia</td>
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<tr>
<td>Czech Republic</td>
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<tr>
<td>Denmark</td>
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<tr>
<td>Ecuador</td>
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<td>Egypt</td>
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<tr>
<td>Finland</td>
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<tr>
<td>France</td>
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<tr>
<td>Germany</td>
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<td>Greece</td>
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<td>Hungary</td>
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<tr>
<td>Iceland</td>
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<tr>
<td>Indonesia</td>
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<tr>
<td>Iran</td>
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<tr>
<td>Ireland</td>
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<tr>
<td>Israel</td>
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<tr>
<td>Italy</td>
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<tr>
<td>Jamaica</td>
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<tr>
<td>Japan</td>
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<td>Jordan</td>
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<tr>
<td>Kenya</td>
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<tr>
<td>Kuwait</td>
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<tr>
<td>Latvia</td>
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<tr>
<td>Liberia</td>
</tr>
</tbody>
</table>
II. **Freedom House Lists of Free, Partly Free, and Not Free Nations**

**Nations Rated as "Free"**  
(87 Nations)

<table>
<thead>
<tr>
<th>Andorra</th>
<th>Mali</th>
</tr>
</thead>
<tbody>
<tr>
<td>Argentina</td>
<td>Malta</td>
</tr>
<tr>
<td>Australia</td>
<td>Marshall Islands</td>
</tr>
<tr>
<td>Austria</td>
<td>Mauritius</td>
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<tr>
<td>Bahamas</td>
<td>Micronesia</td>
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<tr>
<td>Barbados</td>
<td>Monaco</td>
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<tr>
<td>Belgium</td>
<td>Mongolia</td>
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<tr>
<td>Belize</td>
<td>Namibia</td>
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<tr>
<td>Benin</td>
<td>Nauru</td>
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<td>Bolivia</td>
<td>Netherlands</td>
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<tr>
<td>Botswana</td>
<td>New Zealand</td>
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<tr>
<td>Bulgaria</td>
<td>Nicaragua</td>
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<tr>
<td>Canada</td>
<td>Norway</td>
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<tr>
<td>Cape Verde</td>
<td>Palau</td>
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<tr>
<td>Chile</td>
<td>Panama</td>
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<tr>
<td>Costa Rica</td>
<td>Papua New Guinea</td>
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<tr>
<td>Cyprus</td>
<td>Philippines</td>
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<td>Czech Republic</td>
<td>Poland</td>
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<td>Denmark</td>
<td>Portugal</td>
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<tr>
<td>Dominica</td>
<td>Romania</td>
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<tr>
<td>Dominican Republic</td>
<td>Saint Kitts and Nevis</td>
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<tr>
<td>Ecuador</td>
<td>Saint Lucia</td>
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<tr>
<td>El Salvador</td>
<td>Saint Vincent and the Grenadines</td>
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<tr>
<td>Estonia</td>
<td>San Marino</td>
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<tr>
<td>Finland</td>
<td>Sao Tome and Principe</td>
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<tr>
<td>France</td>
<td>Slovakia</td>
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<tr>
<td>Germany</td>
<td>Slovenia</td>
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<tr>
<td>Grenada</td>
<td>Solomon Islands</td>
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<tr>
<td>Guyana</td>
<td>South Africa</td>
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<tr>
<td>Honduras</td>
<td>South Korea</td>
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<tr>
<td>Hungary</td>
<td>Spain</td>
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<tr>
<td>Iceland</td>
<td>Sweden</td>
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<tr>
<td>India</td>
<td>Switzerland</td>
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<tr>
<td>Ireland</td>
<td>Trinidad and Tobago</td>
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<tr>
<td>Israel</td>
<td>Tuvalu</td>
</tr>
<tr>
<td>Italy</td>
<td>United Kingdom</td>
</tr>
<tr>
<td>Jamaica</td>
<td>(excluding Northern Ireland)</td>
</tr>
<tr>
<td>Japan</td>
<td>United States of America</td>
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<tr>
<td>Kirbati</td>
<td>Uruguay</td>
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<tr>
<td>Latvia</td>
<td>Vanuatu</td>
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<tr>
<td>Liechtenstein</td>
<td>Venezuela</td>
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<tr>
<td>Lithuania</td>
<td>Western Samoa</td>
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<tr>
<td>Luxembourg</td>
<td></td>
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<tr>
<td>Malawi</td>
<td></td>
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</tbody>
</table>
NATIONS RATED AS "PARTLY FREE"
(53 Nations)

Albania  
Antigua and Barbuda  
Armenia  
Azerbaijan  
Bangladesh  
Bosnia and Herzegovina  
Brazil  
Burkina Faso  
Central African Republic  
Colombia  
Comoros  
Croatia  
Eritrea  
Ethiopia  
Fiji  
Gabon  
Georgia  
Ghana  
Guatemala  
Guinea-Bissau  
Haiti  
Indonesia  
Jordan  
Kuwait  
Kyrgyzstan  
Lesotho  
Liberia  
Macedonia  
Madagascar  
Malaysia  
Mexico  
Moldova  
Morocco  
Mozambique  
Nepal  
Nigeria  
Pakistan  
Paraguay  
Peru  
Russia  
Senegal  
Seychelles  
Sierra Leone  
Singapore  
Sri Lanka  
Suriname  
Tanzania  
Tonga  
Turkey  
Uganda  
Ukraine  
Zambia  
Zimbabwe
NATIONS RATED AS “NOT FREE”
(50 Nations)

Afghanistan
Algeria
Angola
Bahrain
Belarus
Bhutan
Brunei
Burundi
Cambodia
Cameroon
Chad
China
Congo (Brazzaville)
Congo (Kinshasa)
Cote d’Ivoire
Cuba
Djibouti
Egypt
Equatorial Guinea
Gambia
Guinea
Iran
Iraq
Kazakhstan
Kenya

Laos
Lebanon
Libya
Maldives
Mauritania
Myanmar [Burma]
Niger
North Korea
Oman
Qatar
Rwanda
Saudi Arabia
Somalia
Sudan
Swaziland
Syria
Tajikistan
Togo
Tunisia
Turkmenistan
United Arab Emirates
Uzbekistan
Viet Nam
Yemen
Yugoslavia