The Green Spiral: Policy-Industry Feedback and the Success of International Environmental Negotiation

By

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A dissertation submitted in partial satisfaction of the

requirements for the degree of

Doctor of Philosophy

in

Political Science

in the

Graduate Division

of the

University of California, Berkeley

Committee in charge:

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Fall 2014

Abstract

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States cannot yet consistently solve international environmental problems requiring cooperation. Some international environmental negotiations result in clear successes. Others seem to fail or simply flatline, failing to progress beyond initial modest progress, even when they apply the "lessons learned" from prior rounds of negotiation. Existing scholarship fails to fully explain this variation. This lack is particularly troubling given that major environmental negotiations often address serious, even existential threats that appear to require international cooperation to effectively address.

Existing theory that attempts to explain negotiation success and failure focuses on a variety of factors: (1) the advancement of knowledge and structures for the dissemination of knowledge; (2) institutional features such as treaty design, particularly features designed to solve problems of collective action; (3) structural features of the issue area, such as the scope and complexity of the problem or the existing configuration of relevant interests at the domestic level; and (4) a variety of miscellaneous factors such as leadership.

But even taken collectively, these existing lines of explanation do not coherently explain the variation seen even within two key issue areas, ozone and climate change. Many success factors seen in ozone were present in climate change as well, but failed to lead to success there. On the other hand, one real differentiator between ozone and climate – the greater difficulty of the climate problem – appears to explain negotiation outcome but does not make sense given that unilateral action has been possible at the domestic level. If climate change is simply too daunting to address, why have some states still engaged in significant unilateral regulation?

A plausible answer lies in a process largely unutilized by previous scholarship on international negotiations: policy-industry feedback processes, which I refer to as the "green spiral." In such feedback processes, initial policy moves lead to adaptive industry responses, such as changes in capital investment. These adaptive responses actually

change material industry interests, stimulating adaptation in existing "substitutable" industries that can adapt, growth in "winner" industries that benefit from regulation, and shrinkage in "loser" industries that bear high costs from regulation. In other words, these adaptive responses shrink coalitions against regulation, and grow coalitions for regulation. These changes in turn feed back into policymaking by increasing the political viability for international cooperation or regulation, allowing more regulation in the next round of negotiation or policymaking. More stringent regulation in the next round then triggers further industry reconfiguration; and so on, in a policy-industry feedback spiral.

Green spiral processes do not always occur; and they may occur at the domestic level (as a feature of domestic policymaking) even when they do not occur at the international level. In this dissertation, I argue that their presence or absence at the international level explains the contrasting success and failure of the ozone and climate negotiations; and that the same dynamics explain variation at the national level seen within cases. In addition to characterizing these processes in ozone and climate, I explore the scope conditions for and policy implications of these processes in environmental negotiation and policymaking generally. Finally, I discuss the implications of this research project for existing and current scholarship.

ACKNOWLEDGMENTS

There is a set of people without whom this dissertation would quite simply not exist. I am immeasurably grateful to my family: to my mother Bonnie Allen and my father Mason Kelsey, and to my uncle and aunt, Walt and Edwina Driggers, for their love and support. I am indebted to the mentorship, scholarly guidance, and intellectual opportunities I received from my committee, Professors John Zysman, Steve Weber, and Michael Hanemann, for their guidance and insight. Their discussion, comments, questions, critiques, and judicious exhortations have been invaluable; their feedback has made this work deeper, more thoughtful, and very likely more coherent than it would otherwise have been. Finally, I could not have survived grad school without the friendship, conversation, and kindness of some of the best friends around: I am grateful to Sara Chatfield for her insight, optimism, empathy, and unflagging comradeship in the battlefields of academia; to Jay Purcell for his humor and integrity; to Genevieve Lester for many late-night pep talks; and to Ben Oppenheim for great conversations about crazy ideas.

I have benefited enormously from the communities of scholarship I have found at Berkeley: the Institute of International Studies during my early years at Berkeley; the scholars, staff, and students of the Berkeley Roundtable on the International Economy, where I found a home; the international relations faculty and students of the MIRTH colloquium; and the researchers of the Center for Information Technology Research in the Interest of Society and the Energy and Resources Group, both of which have expanded my horizons. I am grateful to the amazing faculty I have had a chance to work with at Berkeley; and especially to Ron Hassner, Amy Gurowitz, TJ Pempel, Michaela Mattes, Paul Wright, Costas Spanos, and Gary Baldwin.

Finally, I am very grateful to the fellow students from whom I have received support, critique, working accountability, encouragement, and advice: Mark Huberty, Allan Dafoe, Melissa Griffith, Alice Ciciora, Brian Palmer-Rubin, Ben Bartlett, Jason Klocek, Rochelle Terman, Crystal Chang, and many others.

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CHAPTER 1: INTRODUCTION

GOALS

States can't yet consistently solve major international environmental problems. We succeed at one effort, like ozone depletion, only to fail at the next, as with climate change. This is so even though the latter is a greater threat and, in theory, benefits from the "lessons learned" from ozone. Failures in environmental negotiation are important partly due to their environmental effects. But they are also important because environmental negotiations are part of a broader class of *international public goods negotiations*:[1] negotiations over problems that require international cooperation, and in which states that did not contribute to a solution cannot be excluded from enjoying its benefits. Why do these negotiations sometimes succeed and sometimes fail? And why do some negotiations display a "ratchet effect," with one round locking in gains and the next round improving upon those gains, while other negotiations seem to flatline?

These problems are famously hard to solve. In public goods problems, all players benefit from a solution, even if they didn't contribute, and helping out is costly. So states have good reason to free ride, letting other states pay for solutions while they themselves carry on with business as usual. Moreover, even if a state *is* willing contribute, it is (rightly) concerned about others free riding. States don't want to bear problem-solving costs only to find that no one else is contributing and the problem is unresolved. These factors in concert make states reluctant to sign on to public goods deals.

Nonetheless, international environmental negotiations do not always fail. Ozone negotiations, for instance, were a clear success. The question is not *whether* we can create effective international environmental cooperation, but how we can do so *consistently* across most or all problems. Can we expand the range of problems we are able to solve?

The central aim of this dissertation is to add a new conceptual tool to our understanding of success in environmental treaty making. I will argue that our prior understanding of what makes environmental treaties work is incomplete; that there is a mechanism not currently well understood at the international level, which partially determines treaty making success; and that an understanding of this mechanism has strategic implications that can help us solve future environmental treaty making problems.

Specifically, I will propose that a mechanism I refer to as the "green spiral" can in some cases act over time to change the material interests of economic blocks like individual industries, adapting them to regulation. Adaptation makes industries tolerant or supportive of regulation, in effect removing them from anti-regulation coalitions and/or adding them to coalitions pushing for regulation. Such shifts explain both the overall success of environmental negotiations and the "ratchet effect:" if each round of

[1] I follow the literature here in using "public goods" to describe the goods provided by these types of negotiations. In fact, the more general "non-excludable goods" would be more accurate, as environmental issues like ozone or climate can be conceptualized as *either* public goods or common-pool resources. For instance, the ozone layer issue area appears non-rivalrous if one defines the "good" as the ozone layer itself, but rivalrous if one defines the "good" as the ability to emit CFCs in the course of economic activity.

negotiation enlarges the coalition for regulation, it makes sense that each round could lock in additional gains.

HOW IS EXISTING THEORY INCOMPLETE?

A look at the successful ozone negotiations and the thus-far unsuccessful climate negotiations demonstrates the incomplete nature of our current theoretical toolkit for international treaty making. None of the existing theories, either individually or in aggregate, provides a coherent explanation for all three of the following:

1) Success of the ozone negotiations
2) Failure (thus far) of the climate negotiations at the international level
3) National-level variation: differences in national negotiating positions, as well as the ability of some states to successfully pass stringent local regulations

The set of theories that appears to explain ozone success runs aground on the failure of climate change. But theories advanced to explain the ozone/climate contrast run aground on variation at the national level *within* climate. Broadly, I believe none of these theories explains the cases comprehensively because none explain a critical underlying issue: in a difficult issue area where political will does not initially exist for a treaty that creates a full solution, how can underlying interests change over time in ways that create political will? I will explain what I mean here by going through these in a bit more detail.

Academic explanations for success and failure of treaty making efforts fall into two camps: strategies and structures. Strategies are measures actors can take to affect negotiation outcomes. Structures are underlying conditions or characteristics – for instance, of the players or the problem – that affect the difficulty of a successful outcome *regardless* of strategies applied.

Scholars have argued that a specific set of strategies made the ozone negotiations successful. In particular, much has been made, first, of the creation of scientific consensus and the activity of communities of experts; and second, of the complementary importance of using a multi-round negotiating design that allows negotiators to consolidate politically viable measures in one round, and ratchet up efforts in the next round, after knowledge advanced. Yet these strategies were both applied to the climate negotiations, and did not result in success. Therefore, they do not, individually or together, fully explain environmental treaty making success.

The most common explanation for the contrasting failure in climate change is structural. Many scholars argue that the climate issue area is just harder than ozone. Solving it involves too much cost in too many industries. Thus, there are too many groups whose interests lie in opposing cooperation and regulation. This argument suggests that the configuration of interests found in climate change simply does not support a cooperative solution.

Scholars have also suggested that there are strategies used in ozone but *not* applied to the climate negotiations that account for climate failure. For instance, the ozone treaties used trade measures, punishing non-participating states by excluding them from trade in related goods. Such measures make treaties more attractive in two ways: states want to avoid the costs of being excluded; and they are less concerned about the likelihood of others' free riding. In practice, however, this explanation is a subset of the "it's too hard"

argument. Trade measures were discussed in the context of climate negotiations, but didn't gain traction because there is no political will for them – but why not? This brings us back to the idea that climate is structurally too hard and creates too many opponents.

If we accept that the climate problem is just too hard to solve, we would now be satisfied. The explanation for the observed outcomes would be: "Some public goods problems – like climate – are just too hard, and are therefore not solved. For easier problems – like ozone – the strategies used determine whether a solution is found or not." This is largely where scholarship around environmental treaties rests at this point.

The structural differences between the ozone and climate issues areas are real, but as an explanation for outcomes, broad structural arguments prove unsatisfactory for a separate reason: they do not explain variation between countries *within* an issue area. In fact, climate is not "just too hard" everywhere. Nations like Denmark, and individual US states like California, have unilaterally passed increasingly powerful local regulation. These efforts are particularly puzzling given the real costs of wasting effort when other states do not cooperate. Denmark *cannot* solve the climate problem unilaterally; so why is it willing to bear the costs of regulating anyway?

In sum, prior scholarship offers explanations that make sense of parts of prominent public goods negotiations, but don't explain the full picture. These theories are valuable. Some treaties *are* harder to make than others; strategies *do* matter. But even limiting our scope to just two major cases, explanations advanced thus far do not fully explain observed variation. A truly satisfying explanation should be able to account for the variation seen between ozone and climate, and be consonant with the variation seen at the local level within issue areas. Theoretically speaking, there seems to be a missing factor in international treaty making literature. The goal of this work is to characterize that factor, expand theory to account for more of the variation seen, and draw out resulting implications.

THE GREEN SPIRAL MECHANISM

I propose that an additional mechanism is at work in some international environmental negotiations – a policy-industry feedback mechanism that I refer to as a "green spiral."[2] In brief, this policy-industry feedback process works as follows:

1) Initial policy moves – i.e. a first-round treaty – create a stimulus for change in relevant industries. Initial moves are usually moderate or weak.
2) Relevant industries respond by adapting structurally to some degree; i.e., by making new capital investments or changing business practices.
3) These shifts in the structure of industries create shifts in material interests – for instance, a company that builds a factory that makes a pollutant substitute acquires a novel interest in regulation that supports a market for the substitute.
4) As a result, the type and direction of influence exerted by industries on policymakers – through lobbying or other avenues – shifts.

[2] I first presented this mechanism in work done with colleagues for the volume *Can Green Sustain Growth? From the Religion to the Reality of Sustainable Prosperity*. (Kelsey and Zysman, "The Green Spiral.")

5) This shift in influence changes the range of politically viable policy moves, broadening the political window for subsequent regulation.
6) The next round of policymaking occurs in the context of this broader scope of political viability, leading to subsequent additional or stronger policy moves.
7) These subsequent policy moves provide a new stimulus for more industry change, creating more shifts in interests; and so on.

Although the number of rounds may differ by case, at its heart this is conceptualized as an iterative, multi-round, back-and-forth interplay of feedback between policy and industry. This interplay allows for positive movement toward a desired regulatory end-state. Over time, this process can lead to a paradigmatic shift of the economy toward a fully regulation-adapted industrial ecosystem.

EMPIRICAL RESULTS

Detailed reviews of two case studies, the ozone and climate change negotiations, support the importance of this proposed mechanism.

First, in ozone, I find that the green spiral mechanism played an under-recognized role in enabling success. A process of policy-industry feedback explains the momentum seen in the ozone negotiations, where negotiations occurred frequently and each round yielded increasingly stringent regulation. The initial round of regulation in the Montreal Protocol stimulated industry changes, leading to significant investment in CFC substitutes by some leading CFC producers. This in turn shifted the aggregate national interests of key states such as the US and the UK, making additional, more stringent regulation possible during negotiations in 1990. This second round stimulated additional shifts in investment among essentially all of the major CFC producers, creating political space for even more stringent controls in 1992.

And unlike structural explanations, this mechanism also explains national-level variation in negotiating position throughout the ozone negotiations. National industries in key players did not all respond to early regulation at the same rate; countries whose industries responded earlier and more strongly, like the UK, also shifted to pro-regulatory positions at an earlier point in the negotiations. Meanwhile, countries like France, whose industries responded more slowly, remained laggards later in the negotiation process.

Second, the green spiral also provides a satisfactory explanation for the contrast between the ozone and climate change negotiations. The climate change case displays a lack of effective policy-industry feedback and consequent industry evolution. The weak regulations found in the Kyoto Protocol (1997) were insufficient to stimulate significant industry restructuring in two key laggards, the US and China. In both states, green industry has grown at the margins, but fossil fuels industries also continue to grow. Thus, the aggregate national positions of both players have remained relatively static (though particularly strong green growth in China *may* be softening the Chinese position marginally). This lack of fundamental evolution is consonant with the lack of momentum that characterizes those negotiations. Because the balance of key players' national interests did not shift substantially, the scope of politically viable policy did not expand to allow more stringent regulation in the second major negotiation round in 2009.

Finally, again unlike structural explanations, this mechanism also allows us to understand how cases of stringent local regulation have been possible in climate change. Policy-industry feedback can also occur at the national and sub-national level, between rounds of local policymaking. This is what has occurred in California and Denmark: initial rounds of domestic regulation grew local regulation-adapted economic constituencies while shrinking regulation-intolerant ones.[3] As a result, stringent local regulation became possible over time because these areas have a concentration of regulation-adapted industries. These industries benefit from local regulation even in the absence of global regulation. In other words, as a consequence of a green spiral process, regulation can become locally rational even if it does not appear globally rational.

POLICY IMPLICATIONS

The case studies carried out in this research project also allow us to derive some theoretical and practical implications of the mechanism.

I begin by noting that this mechanism has implicit scope conditions. The green spiral explains how and why national positions in environmental negotiations can change between rounds, and hence why some cases can "ratchet up" over time, with more states becoming more willing to accept more regulation in later rounds. Thus, the mechanism is most relevant to "hard cases" where a) sufficient political will exists to allow some initial policy moves; but b) a full solution to the problem is not politically viable given the interest configurations of key players in round one. But these types of cases are both frequent and important enough to be of interest.

Given the apparent importance of this mechanism to at least two major cases of public goods negotiations, an awareness of the mechanism and its policy implications should be useful to policy actors addressing comparable cases. Below, I review conclusions drawn from these cases.

First, in a multi-round negotiation, a policy-industry feedback dynamic means that negotiating rounds are not independent of each other, and should not be thought of as independent. The potential effects of the outcome of one round on the subsequent round should be a key consideration. What is possible in later rounds is a direct result of what has occurred in earlier rounds, because effectively formulated early policy can begin to literally rewrite the interests of key players and hence change the structure of negotiations.

Second, not all policy outcomes are created equal in terms of their effects on industry. In a large-scale, complex problem like climate change, some measures may successfully meet initial emissions reduction targets, but fail to build constituencies for the next round of regulation. In this project, I dive deeply into the details of policy-industry feedback as it plays out internationally and nationally in these two cases. Here, I briefly summarize the findings that emerge from that deep dive.

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[3] In fact, there is a small but useful set of literature on the potential role of feedback effects in enabling climate policy at the local level, partly deriving from the path dependence literature. Important pieces in my view include the analytical case studies conducted for the volume *Can Green Sustain Growth?* (Zysman and Huberty, *Can Green Sustain Growth? From the Religion to the Reality of Sustainable Prosperity*.), and Eric Biber's case study of California climate policy (Biber, "Cultivating a Green Political Landscape: Lessons for Climate Change Policy from the Defeat of California's Proposition 23.")

Research and development (R&D) are necessary but not sufficient. Political science scholarship tends to take interests as given rather than examining changes to interests over time; the study of innovation as a factor that can change interests has been one exception. But my research finds that while creation of novel solutions is necessary – a problem can't be solved if solutions don't exist – it is not in isolation sufficient. Substantial R&D has occurred in both ozone and climate, yielding initially costly but effective solutions in both, but does not appear to be a key driver of interest shifts in either[4].

Similarly, least-cost, incremental solutions are a double-edged sword. When limited political will exists, policymakers lean toward policies primarily or exclusively targeting "low-hanging fruit" – inexpensive, minor changes that yield significant pollutant reduction benefits. This includes direct measures, such as efficiency programs (many efficiency measures are low-cost or even have positive long-term pay-offs). It also includes measures that do the same thing indirectly, i.e. through pollutant pricing or cap-and-trade programs. These types of programs are valued precisely because they provide incentives for industry to discover and execute the least costly ways to reduce pollution; hence they are expected to be highest-efficiency and lowest-impact.

But these types of measures are inherently ill suited to generate fundamental changes in industry interests. Industry interests shift when industry makes significant, difficult-to-reverse changes to investment patterns and business practices – that is, major sunk costs like new capital investment. Least-cost solutions tend to involve minor modifications to existing equipment and practices, rather than substantial changes to capital investment or business paradigms. So least-cost programs tend to generate marginal changes, broadly distributed, rather than fundamental changes in any one industry. If policy-makers exclusively target low-hanging fruit, they may find that in subsequent rounds such fruit has been plucked, but industry interests have not fundamentally shifted. The next round of regulation will therefore be more costly but no more politically viable. Shifting fundamental industry interests may require that policy be at least partially focused on measures designed to elicit structural reconfiguration, such as a combination of targeted direct regulation and subsidies.

Finally, aside from the sheer size and complexity, some more subtle structural characteristics of an issue matter to treaty making success. One is the potential for impacted industries to switch from polluting to non-polluting businesses. In ozone, CFC producers were able to switch to producing CFC substitutes, which were based on related chemistries and drew on similar technologies. This, not just the sheer size or complexity of relevant industries, made ozone a simpler problem to solve, since impacted industries could adapt instead of dying. The picture is more complex in climate change. Some key industries, like fossil fuels, are not obvious candidates for adaptation/substitution, while others, like power generation or grid technology, are. A green spiral may be more likely if policymakers target regulation to provide maximum leverage on the most easily moved industries.

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[4] For opposite reasons: in ozone, the invention of costly but effective solutions occurred meaningfully before the Montreal Protocol but shifts of concrete interests occurred only after initial policy moves spurred concrete investment. In climate, a great deal of innovation has also yielded costly but effective solutions, but aggregate interests have not shifted significantly.

Conclusion – Prospects for Future Cooperation

I began this research out of an interest in the prospects for cooperation in climate change. Since those negotiations are ongoing, it is worth taking a step back and asking what all this tells us about the future prospects for these and other comparable negotiations. I argue that the view offers some hope. One plausible interpretation of the climate change issue is that it stands currently at the point that ozone stood at in the early 1980s, prior to the Montreal Protocol. Political will for international regulation in climate change is currently not strong; but parties are willing to come to the table. Technologies needed to solve the problem do exist. And local stories are developing in ways that could spill over into international fora as local concentrations of regulation-adapted industry develop. In the interim, then, the policy question becomes, how can active policy entrepreneurs use negotiations and negotiation outcomes to prevent the derailment of existing green spirals, help them spread, and generate more of them? This research project makes a start at answering that question.

CHAPTER 2: THEORETICAL BACKGROUND

INTRODUCTION

At its heart, this research project focuses on the question of how states get each other to agree to behave in certain ways over time through negotiation and treaty making. If it succeeds, this project should be relevant to policymakers: it should give parties to interstate negotiations new ideas about what conditions, factors, or strategies they should focus on if they want to create agreements that successfully induce other states to agree to desired outcomes. It should provide useful insight into how to evaluate treaty design and negotiation strategies.

There are certain implicit bounds to this research. It is naturally most concerned with cases where cooperation is not initially readily accessible. If states simply agree to do things they planned to do anyway, the treaty making process is a success, but a trivial one. Policymakers don't usually need to be told how to get each other to do things they all already want to do. Similarly, in some cases, parties may go into negotiation with clearly aligned interests, already in agreement on a desirable objective – needing only to find a focal point to coordinate behavior, or to induce a minority of reluctant parties to cooperate via some sort of direct incentive. These cases are relatively well-explored, and hence of less theoretical interest.

The focus of my interest is on hard case negotiation. These are cases where there appears initially to be limited common ground between states on the type or extent of cooperation desired, due to fundamentally differing interests between parties. A party or parties may desire cooperation on a particular issue, and have enough influence in the international system to bring other parties to the negotiating table, but lack the power to impose an agreement. Because they aren't subject to ready agreement, these cases tend to manifest as multi-round negotiations (which may or may not be formalized within an overarching institution such as the United Nations convention-protocol format). I ask how successful outcomes happen in these kinds of negotiations. How does a state get other states to agreement when other parties initially do not appear to have any easily accessed interest in cooperation, or in the level of cooperation desired? *If existing interests do not support an immediate agreement, when and how does this situation change over time*?

In order to talk about this subject, it is necessary to define what type of variation I am talking about; what constitutes a successful or unsuccessful treaty making process? Generally, I define successful treaty making processes as ones that result in a ratified agreement that contains commitments that appear to genuinely require alterations in behavior; that capture enough participants to have a meaningful impact on the problem at hand; and that yield meaningful amounts of subsequent compliance (to the limits of our ability to judge). Looking specifically at the field of "hard cases" and long-term multi-round negotiation, we see in some cases a particular pattern differentiating successful and unsuccessful treaty making processes. The former "take off" and display momentum toward desired outcomes, with multiple rounds yielding a general trend toward increasingly deep cooperation and stronger commitments. The latter appear to "flatline," with multiple rounds of negotiation failing to generate a satisfactory outcome, or with later rounds unable to improve over weak or merely aspirational attempts in early rounds. Of

course, it is always possible that negotiations may eventually pick up momentum or make a breakthrough. Therefore in a sense it may be better to think of variation as being between successful treaty making processes and not-yet-successful treaty making processes, rather than between success and failure.

We see this pattern in the difference between ozone and climate change. One of the drivers of this project was my interest in accounting for the different patterns seen in the ozone negotiations, which took off, and the climate negotiations, which flatlined. In the ozone negotiations, we see an upward spiral of regulation, from an aspirational framework convention in 1985, to a moderate regulatory agreement in 1987, to increasingly aggressive regulatory agreements in subsequent rounds of negotiations. In the climate negotiations, an initially similar trajectory was seen – an early toothless framework convention, followed by a weak regulatory agreement, the Kyoto Protocol, in 1997. But thereafter, climate negotiations flatlined; subsequent rounds of negotiations failed even to follow up on Kyoto with another weak continuing agreement, let alone move toward more stringent controls.

Another way to state my research question, therefore, is: *why do some difficult multi-round negotiations take off, becoming progressively easier, while others flatline, yielding little or no ultimate progress*? I am going to argue that it is because interests can change over time based on the dynamics of negotiation; in some cases yielding expansion of the coalitions for regulation, and hence shifting the range of politically viable agreements upward.

CASE SELECTION AND RESEARCH CONTENT

To explore this question, I focus on environmental treaty making. Environmental problems constitute interesting hard cases for treaty-makers. They are often difficult to create agreements around because they typically involve protection of a public good or common pool resource, achieved via collective action to alter an existing economic system to eliminate problematic activities such as pollution. This kind of collective action is often costly, which will lead some interests to oppose it. And while such cooperation creates diffuse, widespread benefits, it often does not directly result in concentrated private benefits that might induce particular players to strongly support cooperation. Potential parties always have incentives to free ride because they do not want to expend resources and cannot be excluded from the benefits created by the efforts of any states that do cooperate. Thus, environmental treaties tend to involve problems where many agree that the benefits of cooperation are desirable, but cooperation is politically difficult to achieve. Understanding these "hard cases" should be useful to negotiation theory in general; so although I will focus on the subset of environmental treaty making for the majority of this project, my findings likely have some general applicability throughout the sphere of economic treaty making.

I focus on two case studies: ozone and climate change. These two cases are two of the best known, most important, and most extensively studied environmental treaty making efforts on record. They encapsulate the problems of complexity, public goods provision, and distribution of costs and benefits noted above. Moreover, studies of these

two negotiations inform much of the existing literature on environmental negotiation, meaning that studying them effectively speaks to much of the existing literature.

The two cases also make a theoretically powerful pairing because they are related in practice: the two treaties draw on many of the same design elements. The design of the United Nations Framework Convention on Climate Change (UNFCCC) and the negotiating process that took place under it occurred very much in the shadow of the quite successful ozone process. Therefore, ozone and climate change have many similarities, and challenge the scholar to look for the missing factor that accounts for their difference in outcomes.

REVIEW OF THE LITERATURE

Richard Benedick's[5] extraordinarily detailed account of the multiple rounds of the international negotiations around the control of ozone depleting substances posits a set of explanations for the success of these negotiations. His analysis prefigures much of the theory that has subsequently been advanced to explain the success of Montreal and comparable environmental negotiations; so I begin my review of literature by briefly summarizing his explanations. Benedick cites at least seven distinct factors[6], but they can broadly be reduced to three areas.

First, the *spread of knowledge and increased understanding* of the problem over time are central. The negotiations benefited from an on-going advance of scientific understanding, complemented by the spread of public knowledge and the rise of public interest. An important and separate subcategory of advancing knowledge is *technological innovation from industry*: Benedick calls industry's role in the creation of substitute chemicals crucial to treaty success. Second, *institutional features* such as treaty design and process factors were important. In particular, Benedick argues that the design of the treaty making process in the form of a multi-round negotiation in which each round allowed parties to flexibly incorporate advancing scientific knowledge, with relatively low barriers to improvements and amendments, was key. Third, *institutional, personal, and national leadership* make a difference. Benedick lauds the role of organizations (such as the United Nations Environmental Program (UNEP)), individuals (such as Mostafa Tolba, Executive Director of UNEP), groups (such as environmental organizations), and nations (such as the US in acting first, and Germany in breaking with the EC) in pushing forward negotiations even against resistance.

The literature on the ozone negotiations follows this general outline surprisingly closely; many theories proposed to explain the rapid evolution of the negotiations have fallen into generally similar categories. In addition, significant bodies of literature exist that are based on theories around the solution of the collective action problem (an important and distinct subset of literature on institutional and treaty design factors); and structural factors both at the international and domestic levels. Finally, there is a set of literature that, rather than explaining negotiation success, suggests that the ozone negotiations were in fact epiphenomenal, merely codifying actions states were in any case willing to take.

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[5] Benedick, *Ozone Diplomacy: New Directions in Safeguarding the Planet*.

[6] Ibid., 5–8.

Below, I review these strands of literature.

I. Literature based on knowledge, the spread of ideas, and perceptions or understandings

Literature in this category is among the best known and most commonly cited for environmental negotiation literature in general and for ozone negotiations specifically. Because ozone, like many environmental problems, is a technically complex issue whose potential costs are felt by a widely dispersed public, many scholars focus on the question of how knowledge, understanding, and opinion about such problems is generated and communicated to the public and to policymakers. Most simply, a direct connection likely exists between knowledge and treaty success – as the scientific process advances, policy-makers know more about the causes, consequences, and solutions of ozone degradation and hence became more willing to regulate ozone-depleting substances. Therefore, a general perception underlying much scholarship is that whatever helps policymakers understand the problem, and allows for learning and consensus building about the problem, its consequences, and its solutions, is good for treaty making.[7]

Peter Haas'[8] argument that ozone success was predicated on the existence and activities of an epistemic community is particularly well known. Haas posits a community of climate scientists and policymakers, experts with shared understandings about a particular problem, appropriate goals in terms of solving the problem, and appropriate tools for achieving these goals. Particularly in highly technical areas (like environmental problems) where policy-makers face high uncertainty and appropriate courses of action may be unclear, epistemic communities can determine what actions policymakers ultimately pursue. These communities' influence results from a combination of perceived expert authority, and the ability to network with friendly policy-makers, thus transmitting their technical understandings, causal beliefs, and policy goals. Where some scholars simply assert that the spread of knowledge and ideas occurred in the ozone case, and impacted policy formation, Haas attempts to provide a mechanism.

Around Haas is a broader set of other community- and network-based theories. A number of authors have looked more specifically at the factors that make epistemic communities, knowledge brokers, and policy entrepreneurs more effective.[9] A subset of this literature has also pushed back somewhat against an optimistic view of knowledge and consensus building. Some scholars have pointed out that error can work against agreement[10] and can sometimes constitute "negative learning".[11] The role of consensus is

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[7] See for instance Scapple, "Is Consensus Necessary for Effective Environmental Treaties?"; Sebenius, "Challenging Conventional Explanations of International Cooperation: Negotiation Analysis and the Case of Epistemic Communities."

[8] Haas, "Obtaining International Environmental Protection through Epistemic Consensus"; Haas, "Banning Chlorofluorocarbons: Epistemic Community Efforts to Protect the Stratospheric Ozone."

[9] Biermann, "Institutions for Scientific Advice: Global Environmental Assessments and Their Influence in Developing Countries"; Dimitrov, "Knowledge, Power, and Interests in Environmental Regime Formation"; Grundmann, *Mending the Ozone Layer: The Role of Transnational Policy Networks*; Litfin, "Framing Science: Precautionary Discourse and the Ozone Treaties"; Lohan, "A Framework for Assessing the Input of Scientific Information into Global Decisionmaking."

[10] Crutzen and Oppenheimer, "Learning about Ozone Depletion."

contested, with some case studies finding that it helps and others finding that it can be counter productive.[12] Scientific uncertainty may actually have productive aspects; for instance, it might lead policymakers to behave in a precautionary manner.[13]

Also in this general category, but somewhat distinct from the literature above, is a miscellaneous set of explanatory factors that fall under the heading of cognitive and attitudinal factors. This collection of literature includes work on problem framing and risk aversion[14] as well as work examining overall trends in relevant perceptions and attitudes, such as the rise of rationalist attitudes and acceptance of scientific authority,[15] shifts toward post-materialist orientations,[16] or movements toward economic "sustainability" over "classic environmental policy" frameworks.[17]

In sum, this branch of literature tends to suggest (with some caveats) that mechanisms that generate knowledge; encourage consensus; and allow for the spread of knowledge, ideas, and favorable framings or understandings of issues and solutions to policymakers are important success factors for treaty making, especially in complex technical areas. However, it may be most accurate to view knowledge generation and dissemination as necessary but not sufficient conditions for environmental treaty making.[18]

II. Literature Based on Institutional Factors and Treaty Process Design

Another significant and somewhat sprawling area of literature focuses on elements of institutional arrangements (international and domestic) and treaty design that influence the potential for successful treaty making.

At the level of *state institutions and apparatus*, scholars have investigated the effect of various internal structures and institutions on what states can commit to and how or whether they can implement commitments. Potentially relevant internal institutional arrangements include regime type[19]; presence/absence of veto points and an executive-centered policy process (in combination with favorable attitudes)[20]; the role assigned to

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[11] Oppenheimer, O'Neill, and Webster, "Negative Learning."

[12] See Parson, "International Environmental Negotiations: The Current State of Empirical and Analytic Study" for a review. Also Grundmann, "Transnational Policy Networks and the Role of Advocacy Scientists: From Ozone Layer Protection to Climate Change."

[13] Betsill and Pielke, Jr., "Blurring the Boundaries: Domestic and International Ozone Politics and Lessons for Climate Change."

[14] Berejekian, "The Gains Debate: Framing State Choice."

[15] Meyer et al., "The Structuring of a World Environmental Regime, 1870-1990."

[16] Recchia, *Explaining the International Environmental Cooperation of Democratic Countries*.

[17] Jachtenfuchs, *International Policy-Making as a Learning Process? The European Union and the Greenhouse Effect*.

[18] Seaver, "Stratospheric Ozone Protection: IR Theory and the Montreal Protocol on Substances That Deplete the Ozone Layer."

[19] Neumayer, "Do Democracies Exhibit Stronger International Environmental Commitment? A Cross-Country Analysis."

[20] Recchia, *Explaining the International Environmental Cooperation of Democratic Countries*.

litigation and courts[21]; and intra-governmental bargaining.[22] This literature has not, in my judgment, led to a clear consensus on success factors in environmental negotiations.

At the *international level*, scholars have looked at a wide variety of elements of treaty and negotiation design. One common focus for literature is the question of the scope of participation: should leaders push for treaties that are broadly multilateral or global, but shallow; or for relatively narrow, minilateral treaties that may be easier to negotiate and result in deeper commitments? There are theoretical reasons to view broad or global treaties as preferable. Treaties governing the emissions of pollutants that only cover a subset of potential polluters may be self-sabotaging, leading to leakage of polluting activity into non-signatory states and taking valuable industry activity with it. Hence many environmental negotiators have tended to push for global agreements, which may be better in some circumstances.[23] Barrett[24] suggests that full-participation "consensus treaties" may be able to improve on non-cooperative outcomes in some cases. Some scholars have emphasized the role of private interest groups and hence argue that treaties need to be inclusive of private participation, either industry or NGOs[25].

However, there are also potential problems with broad participation. Early work by Mancur Olson[26] examining collective action problems suggested that the larger the group of participants, the further the treaty will fall short of providing desired collective goods. Having fewer participants makes for easier treaty making[27]. Several scholars[28] argue that involving developing countries, with their very different interests, too early could create obstacles. Montreal may have threaded the needle, focusing on industrialized countries initially but relatively quickly building in lagged timelines for developing countries to come on board in the future. Inclusivity can also cause problems in voting: scholars have suggested that treaties requiring consensus or unanimity decision-making will be more difficult and time-consuming to create and modify, and more vulnerable to obstruction, than those with less demanding voting procedures[29].

The type of instrument to be negotiated over has also been a focus of research. One example is the question of whether to negotiate over targets and timetables for reduction,

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[21] Raustiala, "Domestic Institutions and International Regulatory Cooperation: Comparative Responses to the Convention on Biological Diversity."

[22] Barkdull and Harris, "Environmental Change and Foreign Policy: A Survey of Theory," 82.

[23] Schmalensee, "Greenhouse Policy Architecture and Institutions."

[24] Barrett, "Consensus Treaties."

[25] See for instance Susskind, *Environmental Diplomacy: Negotiating More Effective Global Agreements*.

[26] Olson, *The Logic of Collective Action: Public Goods and the Theory of Groups*.

[27] Sandler, "Overcoming Global and Regional Collective Action Impediments"; Sebenius, "Designing Negotiations toward a New Regime: The Case of Global Warming."

[28] Cumberlege, "Multilateral Environmental Agreements: From Montreal to Kyoto - a Theoretical Approach to an Improved Climate Change Regime"; Thoms, "A Comparative Analysis of International Regimes on Ozone and Climate Change with Implications for Regime Design."

[29] Depledge, "Striving for No: Saudi Arabia in the Climate Change Regime"; Olson, *The Logic of Collective Action: Public Goods and the Theory of Groups*, 124:41; Sebenius, "Designing Negotiations toward a New Regime: The Case of Global Warming"; Victor, *Global Warming Gridlock: Creating More Effective Strategies for Protecting the Planet*.

mandating particular reduction levels but allowing states to decide how to meet them; over a generally agreed action such as a harmonized carbon tax; over particular actions or reduction strategies, mandating particular behaviors but not necessarily ensuring that particular reduction levels are met; or over some other strategy.[30] A particular debate that focuses on carbon pricing instruments is the question of how to impose prices on pollutants, an increasingly common strategy in environmental policymaking: by controlling prices (i.e. through emission taxes) or by controlling quantity (i.e. through capping and permitting emissions and allowing trading). Victor & Coben[31] (2005) suggest that Kyoto has emphasized a quantity strategy, perhaps because environmental negotiators have a history with such strategies, but that a price instrument might be better.

Another area of focus has been the use of linkage, the decision to combine multiple related issue areas into one treaty making process. Sebenius[32] argues that the use of linkage presents a trade-off: linkage is an important strategy because it allows participants to find opportunities to make strategic trades on complementary issues, with each party getting something it wants, and identify potentially useful side-payments. This builds supportive coalitions and breaks up blocking coalitions. However, too much packaging together of disparate issues can lead to gridlock.

Finally, a related but distinct area of focus is the question of the flexibility of treaty architectures. Benedick argued that the ozone negotiation process was successful because it was built for flexibility, easily responding to new scientific findings as they updated without having to be totally renegotiated.[33] This claim has been echoed throughout the literature.[34] Treaties need flexibility to respond as new issues surface, with multiple independent working groups and a high-level body to facilitate connections. Step-by-step, incremental agreements and a ratchet process may be useful.

In sum, this branch of scholarship focuses on institutional structures and the design of treaties and treaty making processes; this summary merely scratches the surface of a relatively sprawling literature. But this area of literature is difficult to condense into clear findings, since many conclusions are specific to particular treaty cases, and many findings are conflicting (such as the subset of literature on scope of participation). The most we can say is (1) many scholars believe that simplicity (i.e., in terms of scope of participation and voting mechanisms) can ease treaty making – though Montreal itself provides a counter-example, since Montreal had broad membership and tended to function via consensus[35].

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[30] Aldy, Barrett, and Stavins, *Thirteen plus One: A Comparison of Global Climate Policy Architectures*; Cooper, "Toward a Real Global Warming Treaty"; Victor, *Global Warming Gridlock: Creating More Effective Strategies for Protecting the Planet*.

[31] Victor and Coben, "A Herd Mentality in the Design of International Environmental Agreements?".

[32] Sebenius, "Designing Negotiations toward a New Regime: The Case of Global Warming."

[33] Benedick, *Ozone Diplomacy: New Directions in Safeguarding the Planet*.

[34] See for instance Sebenius, "Designing Negotiations toward a New Regime: The Case of Global Warming"; DeSombre, "The Experience of the Montreal Protocol: Particularly Remarkable, and Remarkably Particular."

[35] Granted, as some scholars have noted (and I would agree), Montreal in practice often boiled down to negotiations between a handful of key players. But this was a function not of institutional design – which allowed for much broader participation – but of structural considerations such as the distribution of producers. See below for a discussion of the effects of domestic material interests on negotiation.

And (2) flexible architectures that allow for incorporation of new knowledge and productive weaving together of issues through linkage are desirable for a number of reasons.

III. Literature on Solutions to Problems of Collective Goods Provision

An extensive literature exists based on the fundamental insight that many environmental treaties attempt to solve the problem of the provision of collective goods in the absence of a higher power that can enforce cooperation. This branch of scholarship fits under the umbrella of institutional factors but is extensive enough to deserve its own section. It often draws on game theoretic concepts: basic game theory suggests that collective goods provision is a difficult problem to solve because it falls in the category of tragedy of the commons or prisoner's dilemma type problems, in which individually rational actions lead to outcomes that are collectively suboptimal. Because states enjoy the benefits of everyone's abatement whether they cooperate or not, they often have incentives to free ride, allowing others to bear the costs of abatement. If all or most players make such individually rational decisions to free ride, however, these decisions in aggregate result in sub-optimal levels of provision of relevant public goods.

Nonetheless, environmental agreements *are* sometimes successful – as in the case of ozone – which suggests the collective action problem might be solved. This strand of literature thus focuses on dynamics that may support such solutions. Its recommendations focus on a specific subset of treaty design features that may achieve this goal.

One general class of solutions revolves around offering incentives to states to provide them with privately rational reasons to cooperate. An obvious possibility is the provision of side-payments to increase the benefits or reduce the costs of cooperation.[36] These include direct transfers, technical assistance, or targeted privileges and exceptions to treaty requirements. A number of scholars suggest that the US provided side payments to various key actors, particularly Japan and Russia, in the negotiation of the Montreal Protocol, in the form of special exceptions or friendly treaty design elements.[37] Europe was seen as offering bargaining enticements to Russia during its push to negotiate and ratify the Kyoto Protocol.

Some authors suggest designing treaties to create "club goods" linked to public goods provision, which only cooperating states can access. Desire to access these club goods then provides states with incentives to participate. Possibilities include the creation of research and development collaborations, where only parties to the treaty share in the value of innovation created by members; access to financing, assistance, and technology transfer; or the creation of emissions trading schemes, which allow cooperative industries of parties to the treaty to capture economic value from abatement. Authors vary on the

[36] Barrett, "International Cooperation for Sale"; Barrett and Stavins, *Increasing Participation and Compliance in International Climate Change Agreements*; Kelleher, "Public Economics and International Environmental Policy: The Case of Ozone Layer Preservation."

[37] Seaver, "Stratospheric Ozone Protection: IR Theory and the Montreal Protocol on Substances That Deplete the Ozone Layer."

types of club good incentives prescribed; some examples are listed in footnotes[38]. An option commonly raised is the inclusion of trade provisions in treaties that allow trade in relevant goods only among members.[39] Trade restrictions both provide incentives to join and reduce the potential for leakage,[40] reducing the threat posed by non-signatories to the effectiveness of the regime. Such restrictions were part of the ozone regime, but have not been incorporated in the climate regime; this is one significant difference between the two.

On the other hand, this solution set also includes mechanisms to discourage free riding or defection subsequent to ratification. Such mechanisms not only increase treaty effectiveness but theoretically make treaty ratification more likely: if parties suspect that their fellow states will defect, they are less likely to ratify and cooperate with a treaty themselves, since they risk being taken advantage of. Hence, measures that make defection less likely in the future might also make agreements more likely to come into being in the first place. This includes provisions that provide for repeated interaction[41] and make it easy for states to punish each other for defection.[42] Design elements that provide for penalties and trade restrictions – the flip side of the trade measures discussed above – in the event of failure to comply are also seen as productive.[43]

Credibility of commitments are important for the same reason: if commitments are credible, potential parties will have less to fear in terms of future defection of other parties. Urpelainen[44] suggests that multi-round gradualism – slow progress over multiple rounds of negotiation – is productive because only small, relatively short-term commitments are credible. Each state can be sure it is not getting ahead of other parties, locking it into higher level of economic reforms that may not be matched if other parties aren't taking action of their own. McEvoy & Stranlund[45] suggest that the appointment of an independent monitor to watch for defection may reduce the instances in which an agreement *can* be reached, but increase the number of states willing to ratify if it *is* reached.

Generally, the architecture of treaties should not make free riding easier or the prospect of eventual defection easier or more attractive. Architectures that allow for

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[38] Barrett and Stavins, *Increasing Participation and Compliance in International Climate Change Agreements*; Victor, *Global Warming Policy after Kyoto: Rethinking Engagement with Developing Countries*; Victor, *Global Warming Gridlock: Creating More Effective Strategies for Protecting the Planet*.

[39] Barrett, "Montreal versus Kyoto: International Cooperation and the Global Environment"; Cumberlege, "Multilateral Environmental Agreements: From Montreal to Kyoto - a Theoretical Approach to an Improved Climate Change Regime"; Kahler, "Multilateralism with Small and Large Numbers"; Thoms, "A Comparative Analysis of International Regimes on Ozone and Climate Change with Implications for Regime Design."

[40] Charnovitz, "Trade Measures and the Design of International Regimes."

[41] Setear, "An Iterative Perspective on Treaties: A Synthesis of International Relations Theory and International Law."

[42] Downs, "Constructing Effective Environmental Regimes."

[43] Barrett and Stavins, *Increasing Participation and Compliance in International Climate Change Agreements*; Downs, "Constructing Effective Environmental Regimes."

[44] Urpelainen, "Domestic Reform as a Rationale for Gradualism in International Cooperation."

[45] McEvoy and Stranlund, "Self-Enforcing International Environmental Agreements with Costly Monitoring for Compliance."

leakage are seen as counterproductive.[46] Along these lines, treaties with differentiated responsibilities (like the Montreal and Kyoto Protocols) may be problematic because they institutionalize free riding by developing countries.[47] The use of institutional design elements like participation thresholds for entry into force, or weakest-link rules (in which level of participation is set by the "weakest link") may help diffuse concerns, discourage free riding, and make participation more attractive.[48]

In sum, this branch of literature suggests successful treaty making results from designs that increase private incentives to participate (via direct incentives or the creation of club goods, or by reducing the costs of participation); reduce incentives to defect (through punishment or exclusion from club goods); increase the credibility of commitments; and generally avoid being permissive of free riding, defection, and non-compliance. A particular recommendation by several scholars is the use of trade measures, because they offer a means (already used in some existing treaties) of providing club goods as an incentive for permission and a means of punishing defection.

IV. Leadership

Leadership is commonly seen as an ingredient in successful treaty making.[49] Negotiations benefit from having an influential state leader pushing for cooperation, particularly if that leader has a significant stake in the polluting industries or activities.[50] Grundmann argues that differences in leadership help explain why Montreal was more successful than Kyoto: the ozone efforts benefited from active persuasive efforts by the US, a leader in those negotiations, while the climate negotiations have not seen nearly as much active persuasive effort from Europe. Sjöstedt[51] argues that a lack of institutional capacity undermines the EU's ability to exercise leadership in the area of climate. Other contemporary accounts credit Europe and the UNFCCC bureaucracy with greater effort; while Europe had difficulties organizing it certainly did push for resolution and engage in some level of deal-making and offering of incentives.

Leadership may also be exercised by institutions or individual actors. A subset of literature on leadership focuses on the role of treaty secretaries and party chairs. Bauer[52] argues that treaty secretaries can help determine treaty outcomes, using influence based on bureaucratic authority, perceptions of neutrality and professionalism, personal leadership and diplomacy, and control over the drafting of official documents. Similarly,

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[46] Charnovitz, "Trade Measures and the Design of International Regimes"; Sandler, "Overcoming Global and Regional Collective Action Impediments."

[47] Barrett, "Montreal versus Kyoto: International Cooperation and the Global Environment."

[48] Sandler, "Overcoming Global and Regional Collective Action Impediments."

[49] Benedick, *Ozone Diplomacy: New Directions in Safeguarding the Planet*; Tolba, *Global Environmental Diplomacy: Negotiating Environmental Agreements for the World, 1973-1992*.

[50] Grundmann, "Transnational Policy Networks and the Role of Advocacy Scientists: From Ozone Layer Protection to Climate Change"; Sandler, "Overcoming Global and Regional Collective Action Impediments."

[51] Sjöstedt, "The EU Negotiates Climate Change: External Performance and Internal Structural Change."

[52] Bauer, "Does Bureaucracy Really Matter? The Authority of Intergovernmental Treaty Secretariats in Global Environmental Politics."

Tallberg[53] suggests that chairs of negotiation have independent influence in the form of agenda-setting capabilities, brokerage, and representation of options. More generally, international organizations play enabling roles such as preparing documents, advising participants, providing expertise[54], or providing a "public sphere" space[55] which allows for more effective representation of interests. In essence, these types of arguments suggest that international institutions and leading figures within them have a certain amount of power to influence understandings of available or appropriate solution sets and their perceived desirability. As noted above, Benedick[56] credits the leadership of Mostafa Tolba in the ozone negotiations as being an important driver for cooperative outcomes. Oberthür and Ott laud Chairman Raúl Estrada-Oyuela's leadership at the Kyoto negotiations.[57]

In brief, this literature suggests that the existence of strong leadership at multiple levels contributes to treaty success.

V. Structural Factors 1 – Systemic Level

The arguments above largely focus on strategies – choices and actions available to relevant actors. There are also a variety of factors, however, that are essentially structural and less obviously under actors' immediate control than the actions and choices suggested above. These too present possible explanations for negotiation success or failure, and particularly for the variation in success between the ozone and climate cases.

The most important structural explanations of environmental treaty success or failure focus on the natural characteristics of the problem. Because scholars have increasingly wanted to explain the intractability of the climate problem, much of this work relates to climate change. The climate change issue area is seen as posing a combination of structural issues.

Perhaps most importantly, climate is simply a big, complex problem, affecting many economic sectors and other constituencies, with solutions implying costs to many industries as well as consumers[58]. But there are a variety of other structural features potentially relevant to treaty making difficulty. One is high scientific uncertainty.[59] Another is a problematic cost-benefit timeline (the costs of abatement are near-term, while

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[53] Tallberg, "The Power of the Chair: Formal Leadership in International Cooperation."

[54] Loibl, "The Role of International Organisations in International Law-Making International Environmental Negotiations - an Empirical Study."

[55] Pulver, "A Public Sphere in International Environmental Policies: The Case of the Kyoto Protocol Negotiations."

[56] Benedick, *Ozone Diplomacy: New Directions in Safeguarding the Planet*.

[57] Oberthür and Ott, *The Kyoto Protocol: International Climate Policy for the 21st Century*.

[58] Sebenius, "Designing Negotiations toward a New Regime: The Case of Global Warming," 118; Thoms, "A Comparative Analysis of International Regimes on Ozone and Climate Change with Implications for Regime Design," 823. A modified form of this argument suggests that it may be more cost-effective to address climate change later rather than sooner. A well-known example is Nordhaus (Nordhaus, "Modeling Induced Innovation in Climate-Change Policy"). Such arguments suggest that a lack of cooperation on climate change mitigation now may in fact be rational.

[59] Heller, "Environmental Realpolitik: Joint Implementation and Climate Change."

the benefits of abatement are long-term).[60] The *arrangement* of costs and benefits can be important: for instance, in climate the benefits of abatement are diffuse and affect poorly organized constituencies while the costs affect more concentrated, well-organized constituencies;[61] moreover, mitigation of climate change does not offer up-front mutual net gains to most states.[62] Separately, the consequences of climate change differ by region in ways that may not benefit negotiation[63]; the costs of abatement are likely to be highest in developed countries, while the developing countries are likely to be hardest hit by the negative effects of climate change.

Some of these factors clearly generalize across many environmental issue areas while others do not. Ozone also suffered from scientific uncertainty, and the issue of short-term costs vs. long-term benefits. Although the question can be debated (some authors, such as Oye & Maxwell[64], argue that producers such as Du Pont and ICI expected concentrated commercial gains), in general ozone was similarly a problem in which the costs of abatement were concentrated, but the benefits were diffuse; and mutual private net gains were not immediately achievable for many states. On issues of scale and complexity, however, the climate problem is in fact quite unique: it poses a fundamentally larger and more complex problem than did ozone depletion, affecting a larger number of industries and with significantly larger expected costs for abatement.

Possibly surprisingly, the literature on environmental treaties has not focused particularly on power, a structural variable that is usually privileged in international relations literature. Seaver provides a review of common international relations perspectives on environmental treaty making that considers but largely rejects structural realist power considerations as a major explanatory factor. Variants of power-based theories such as hegemonic stability theory (HST) may do better, but HST fails to explain a significant proportion of the actual observed negotiation behavior, and it is unclear that the US really had hegemonic control of the CFC industry in particular.[65] In addition, the effects of hegemony on treaty making success are ambiguous.[66] Grundig[67] argues that the ozone case has fewer national security implications than does the climate case, which means negotiators were less concerned about relative gains concerns in ozone than they

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[60] Ibid.; Sandler, "Overcoming Global and Regional Collective Action Impediments."

[61] Oye and Maxwell, "Self-Interest and Environmental Management". Oye & Maxwell suggest that both DuPont and ICI expected to realize gains from regulation. I will argue in the following chapters that this can only be understood in the context of a process by which early regulatory moves changed the interests of these companies such that they came to value regulation; it was not, in other words, a case of simply capitalizing on existing interests.

[62] Sandler, "Overcoming Global and Regional Collective Action Impediments."

[63] Heller, "Environmental Realpolitik: Joint Implementation and Climate Change."

[64] Oye and Maxwell, "Self-Interest and Environmental Management."

[65] Seaver, "Stratospheric Ozone Protection: IR Theory and the Montreal Protocol on Substances That Deplete the Ozone Layer."

[66] Falkner, "Hegemony and the Global Environment."

[67] Grundig, "Patterns of International Cooperation and the Explanatory Power of Relative Gains: An Analysis of Cooperation on Global Climate Change, Ozone Depletion, and International Trade."

are in climate; but it is unclear that this difference amounts to more than a recognition of the differing size and impact of the problem.

In sum, then, structural explanations suggest that treaties will be most easily concluded when they have low complexity and low scientific uncertainty; favorable cost/benefit dynamics (costs are net positive, or low, or allocated in ways that favor agreement; mutual net gains are available, particularly private gains); favorable timelines (benefits of abatement are not too long-term versus costs); and favorable scope (not too large, too expensive, or too complex); and perhaps when they have favorable power dynamics (a key backer that is powerful or, ideally, a hegemon). For my purposes, the clearly salient take-away is the *difference in issue area scope and complexity between ozone and climate change*.

VI. Structural Factors 2 – Configuration of Domestic Interests

A set of explanations worth considering separately is the influence of existing domestic material interest structures on negotiating positions. Widespread literature suggests that individual states' stances derive from domestic configurations of material interests, particularly industry. Many scholars treat this as an underlying given, referring in an ad hoc manner to configurations of domestic interests, particularly industry, to explain individual states' stances in negotiations even while proposing other overarching explanations for negotiating behavior or outcome. Some literature addresses the point more directly. Sandler[68] notes in a broader review that collective action is easier to achieve when there are material gains from the efforts. Sprinz & Vaahtoranta[69] argue that states are more likely to favor an agreement if national economic costs of environmental degradation are high, and economic costs of abatement low. Stranlund[70] finds that countries will be reluctant to cooperate if they have a great deal of sunk capital investment in polluting facilities. Sebenius[71] argues that negotiation success means crafting winning coalitions of interests at the domestic level and avoiding or breaking up blocking coalitions. Some scholars have looked in a substantial and detailed way at how industry interests and influence impact the outcome of treaty making and policymaking in general.

For my purposes, one particularly relevant piece is the work of Jonas Meckling;[72] Meckling examines the impact of transnational business coalitions on the outcomes of treaty making and policymaking in climate. This work is noteworthy both because Meckling provides a detailed analysis of the relationship between business interest coalitions and climate policymaking, and because he lays out a spectrum of business responses to the potential for regulation, from anti-regulatory to pro-regulatory risk management (in which business sees regulation as costly but likely, and applies its

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[68] Sandler, "Overcoming Global and Regional Collective Action Impediments" Sandler actually argues that Montreal is a case where most parties achieved material gains; I would argue that although this was likely true ultimately, it was not how industry parties perceived the situation initially.

[69] Sprinz and Vaahtoranta, "The Interest-Based Explanations of International Environmental Policy."

[70] Stranlund, "Sunk Capital and Negotiated Resolutions of Environmental Conflicts."

[71] Sebenius, "Designing Negotiations toward a New Regime: The Case of Global Warming."

[72] Meckling, *Carbon Coalitions: Business, Climate Politics, and the Rise of Emissions Trading*.

influence to achieve a style of regulation it views as least harmful) to pro-regulatory market-making (in which business actively desires regulation). Business interests as applied to environmental regulation are often seen as largely oppositional to regulation; in fact, industry can benefit from regulation, and in cases where it does, we should expect to see industry influence exerted on behalf of regulation.

A number of scholars have looked specifically at the interplay of regulation and industry competition. Industry may not desire regulation in a general sense, but may have reasons to push for it under particular competitive conditions. One situation commonly invoked is when unilateral domestic regulations already exist; in this case industry may want international regulation to "level the playing field".[73] Industry might also want regulation if it feels regulation will advantage it relative to competition.[74] Barrett[75] suggests that in situations where foreign industry is perfectly competitive and domestic industry is oligopolistic, governments may have incentives from industry to regulate strongly rather than weakly.

This literature has been applied to the US and DuPont's behavior on ozone.[76] Some suggest that some industry interests actually benefited from ozone cooperation. Prior to Montreal, DuPont may have been interested in capturing gains from a forced switch to non-CFC substitutes, where it may have perceived a potential to profit. Similarly, it has been argued that the US was a leader in pushing for a global ozone agreement because it had already passed domestic regulation; DuPont wanted a level playing field.[77]

However, it is important to note here that this competitive analysis at best only explains why *some* states favor an agreement. In ozone, the very same competitive conditions would presumably lead domestic interests abroad (i.e. in Europe) to oppose a regulatory agreement – as indeed they did, at first. Thus, while these arguments show promise in accounting for some national negotiating positions, they don't directly account for the momentum seen in the ozone negotiations, with steadily rising political viability for increasingly stringent regulation across rounds.

VII. Epiphenomenality

Finally, a subset of literature argues that ozone negotiations were epiphenomenal – rather than affecting behavior, they merely codified behavior that would have occurred anyway. This literature argues that ozone agreements were meaningless or too shallow to matter, relative to unilateral willingness to abate. Murdoch & Sandler argue that Montreal

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[73] Brewster, "Stepping Stone or Stumbling Block: Incrementalism and National Climate Change Legislation," 248; DeSombre, "The Experience of the Montreal Protocol: Particularly Remarkable, and Remarkably Particular," 58; Durkee, "Persuasion Treaties," 120; Falkner, "Hegemony and the Global Environment," 595; Vogel, *Trading up: Consumer and Environmental Regulation in a Global Economy*.

[74] Vogel, *Trading up: Consumer and Environmental Regulation in a Global Economy*.

[75] Barrett, "Strategic Environmental Policy and International Trade."

[76] DeSombre, "The Experience of the Montreal Protocol: Particularly Remarkable, and Remarkably Particular"; Falkner, "Hegemony and the Global Environment."

[77] Oye and Maxwell, "Self-Interest and Environmental Management."

is likely "more symbolic than a true instance of a cooperative equilibrium"[78], based on their findings that CFC cutbacks often exceeded the level of cuts required by the protocol in any given time-period, and that both ratifiers and non-ratifiers carried out CFC cutbacks. Kelleher[79] also suggests that the excessive cutbacks by parties means they (must have) had unilateral reasons to abate. Skjaerseth argues that "evolving scientific knowledge revealed that most actors would gain, and no actors would lose, from phasing out ozone-depleting substances."[80]

How Well Does Current Literature Explain the Ozone-Climate Outcome Variation?

I address the issue of contrasting theoretical explanations for ozone and climate again in Chapter 4, where I contrast the two cases comparatively before addressing the climate case in greater detail. But a discussion here is useful to preface my empirical research. In short, I argue that a theory is stronger to the extent that it helps us understand a greater portion of several forms of variation across the two cases:

1) A strong theory should contribute to understanding cross-case variation: that is, the outcomes of both cases; and in particular, why the outcome of the two cases differed.
2) It should contribute to understanding the particular pace and character of success and failure in multi-round negotiation: why successful cases display momentum across rounds while unsuccessful cases "flatline".
3) It should be consonant with understandings of within-case variation at the domestic level: why do some states and substate regions succeed in passing strong unilateral regulation even when cooperation can't be achieved at the international level?

Cross-Case Variation

Obviously, at a minimum a strong theory of environmental treaty making success should be able to explain the variation outcomes between the two cases. Table 1 summarizes the presence or absence of factors across the ozone and climate cases. As this summary demonstrates, many of the explanatory variables put forward by current theory to explain treaty making success do not vary much across these two cases; in most cases they are present in both; in a few cases they are absent in both. Knowledge generation and diffusion, as well as expert networking and consensus-building, occurred in both cases, so theories of knowledge generation and diffusion do not clearly account for the variation in

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[78] Murdoch and Sandler, "The Voluntary Provision of a Pure Public Good: The Case of Reduced CFC Emissions and the Montreal Protocol," 332.

[79] Kelleher, "Public Economics and International Environmental Policy: The Case of Ozone Layer Preservation."

[80] Skjaerseth, "The 'Successful' Ozone-Layer Negotiations," 294. I note that this particularly strong statement almost certainly goes too far – in fact, the CFC producers demonstrably DID lose, because they lost significant market share to outside alternatives (like non-CFC aerosol cans), and because demand for producers' substitutes never did rise as much as they hoped (see discussion in Chapter 3). CFC users, such as manufacturers of refrigeration equipment, also certainly suffered some costs in terms of redesigning equipment and/or incorporating more expensive CFC substitutes, though these costs may well have been lower than initially predicted, and may have also prevented loss of market share from ideologically motivated consumers.

Table 1: Incidence of Potential Explanatory Factors Across Ozone and Climate Cases

EXPLANATION	OZONE	CLIMATE	NOTES
Advancing scientific knowledge	✓	✓	
Activity of epistemic communities and knowledge networks	✓	✓	
Uncertainty and error	✓	✓	
Long-term trends toward environmentalist thinking	✓	✓	
Flexible convention/protocol format w/ ability to update in response to science	✓	✓	However, note that some argue that climate negotiations were less flexible in format
Side payments offered to reluctant players	✓	✓	
Repeated interaction	✓	✓	
Limited participants	✗	✗	
Majority voting rather than consensus procedures	✓/✗	✗	Ozone negotiations had less restrictive voting rules but operated on consensus in practice
Incentives/club goods from trade measures	✓	✗	**Begs the question of why trade measures were not used in climate.**
Punishment for defection via trade measures	✓	✗	
Targets and timetables (choice of instruments)	✓	✓	
Leadership	✓	✓	
Role of hegemon	✗	✗	US powerful but not a hegemon within relevant economic sectors.
Scientific uncertainty	✓	✓	
Short-term costs, long-term benefits	✓	✓	
Concentrated costs, diffuse benefits	✓	✓	
Problem limited in scope and scale	✓	✗	**But this begs the question of why national positions vary strongly on both issues.**
Configurations of domestic interests favor observed outcomes	✓	✓	**But these configurations change over time. Why?**

outcomes. For the most part, institutional design variables also do not clearly differentiate the ozone and climate cases. The obvious exception is *enforcement mechanisms in the form of trade measures* (present in ozone and not in climate). Also, the *scope, scale, and complexity of the problem* were significantly larger in climate than in ozone. At first glance, then, these are comparatively strong explanations for the differing outcomes; and in fact they have both been presented to explain that difference. I note, however, that since neither are characterized by change over time, it is unclear that either explains the

pace and character of negotiation success – that is, the characteristic momentum seen in ozone negotiations and not in climate.

The first factor – trade measures – is a clear differentiator, but is more convincing as an intervening variable than as a base cause of variation. The ozone negotiation process did indeed incorporate measures that restricted trade in closely relevant industries to parties to the Protocols, creating an incentive to participate and a penalty for non-participation. The Kyoto Protocol did not. But climate negotiators were certainly aware of the possibility of negotiating trade measures. If Kyoto lacks trade measures, it does so because parties to negotiation did not want trade measures, or lacked the political will to achieve them. This begs the question – why was there greater political will for this potentially helpful but difficult element in ozone than in climate?

Within-Case Variation

Beyond cross-case variation, I also argue that a truly good theory should be able to explain or at least be consonant with the variation in *individual states'* willingness or unwillingness to ratify treaties. Treaty making success is determined by countries' individual willingness to sign on to the agreement drafted. Therefore, a strong theory of treaty making should also be consonant with the different positions of parties (for and against agreement) during both ozone and climate negotiations.

Within-case variation is important because it calls into question the adequacy of the second potential explanatory factor identified above – structural variation in scope and scale of the problem – as a full explanation. Although the scope and scale of the issue area does vary significantly between ozone and climate, structural variables of this sort don't explain the variation in state behavior. If climate is simply too costly, to big, and too complex for states to want to tackle, why was the EU willing to act (even weakly) as a leader, and why was it willing to ratify the Kyoto Protocol? If ozone was a relatively simple problem to solve, why did an ozone agreement initially face quite real opposition from many European countries, and continue to face opposition from Southern European countries well into the negotiation process? Why, as I will delve into further in Chapter 5, do subsets of non-signatories like California and Denmark pursue much stronger-than-average climate regulation unilaterally in the face of weak or non-existent cooperation internationally?

Structural factors at the domestic level have promise with regard to within-case variation. Positions of individual players at any given point are typically consonant with configurations of domestic interests at that point (see Chapters 3 and 4 for more detail). When states' positions change, it is often possible to point to a change in underlying domestic interest configurations. But although cataloging the state of domestic interest configurations at any given point seems to do a good job of explaining a particular round's outcome, it doesn't provide a coherent explanation of why interests and positions change over time, and why they change in convergent ways that lead to successful treaty outcomes that were not previously supported.

A MISSING FACTOR?

This review suggests a missing factor related to shifts in domestic industry interests over time. If negotiations seem to follow domestic-level and particularly industry interests, and hard-case negotiations achieve success when domestic interest configurations shift in ways that allow for ultimate agreement, what accounts for such shifts in industry interests? Are they purely exogenous, or can they be accounted for in a theory of negotiation?

As I will explore in greater depth in Chapter 2, I propose that a *policy-industry feedback effect* accounts for shifts over time in industry interests and national positions in negotiations. Outcomes of policymaking in early rounds lead to responses in industry (particularly shifts in capital investment) that lead to changes in the fundamental interests of relevant industries. These changes in interest in turn change the range of politically viable policy moves, and thus feed back into policymaking by making more stringent policy newly viable. Subsequent policy moves provoke further industry responses, further increasing the range of viable policy, and so on. Over the next three chapters, I will argue that the presence or absence of such a mechanism provides a strong explanation for the international outcomes of ozone and climate negotiations; as well as for national-level outcomes such as negotiating positions and unilateral domestic policymaking.

The concept of a policy-industry feedback loop as an explanatory factor for the success of international environmental negotiations is not one that has been much explored. As a result, this concept represents a largely novel explanation relative to the existing literature in international environmental negotiation. In the next few paragraphs, I look at what prior literature has had to say about two relevant concept areas in the context of international environmental negotiation: causes of changes to industry interests relevant to negotiating position; and processes of policy-industry feedback.

Only a few strands of literature address the question of what prompts changes in the material domestic interests relevant to positions in international negotiations, and largely not very satisfactorily for my purposes. Prior literature has dealt with effects of regulation on industry and industry interests. One strand deals with the effects of innovation and technological spillover, arguing that innovation – possibly driven by unilateral domestic policy – lowers the cost of pollution abatement over time, and hence reduces the resistance to regulation.[81] Levy[82] suggests that the availability of substitutes coupled with the maturation of existing (polluting) products into commodity products may create new incentives for industry to want regulations that force a shift to higher-profit substitutes.

As discussed above, a second strand of literature focuses on the responses of industry to unilateral domestic regulations. There are several arguments here, many of which trace back to David Vogel's[83] well-known work on the potential for free trade to spread or strengthen environmental and consumer regulation. One is that unilateral

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[81] Chatterji et al., *Unilateral Measures and Global Emissions Mitigation*; Hale and Urpelainen, "When and How Can Unilateral Policies Promote the International Diffusion of Environmental Policies and Clean Technology?"; Wagner, *The Porter Hypothesis Revisited: A Literature Review of Theoretical Models and Empirical Tests*.

[82] Levy, "Business and International Environmental Treaties: Ozone Depletion and Climate Change."

[83] Vogel, *Trading up: Consumer and Environmental Regulation in a Global Economy*.

regulation leads to changes in industry position both at home[84] (this is a widespread gloss in discussions of DuPont) and potentially abroad[85]. Companies that have been unilaterally regulated at home, or that face a patchwork of regulations in export markets, might want to level the playing field through harmonization. Alternately, domestic companies pressured by foreign competition may *seek* regulations if they think they will be better able to meet them in a cost-effective manner than their foreign competitors. (Vogel also alludes to the potential role of feedback effects – when companies invest in capacity to meet higher foreign standards, this could feed back into local policy making either because adapting companies want to harmonize local regulation to the new capacity, or because NGOs seek to capitalize on these new capabilities with stricter local regulation – but this is not really the focus of the work and Vogel does not develop the point further theoretically.)

I find two articles specifically exploring the potential for policy-industry feedback as a critical factor in international environmental negotiations. Brewster[86], drawing in part on path dependence literature, looks narrowly at the potential effects that U.S. legislation under consideration in the Waxman-Markey and Lieberman-Warner bills might have on subsequent climate negotiation. Brewster's analysis is interesting, but it is largely a prospective theoretical analysis of the possible consequences of specific policies under consideration. She focuses narrowly on cap-and-trade and carbon tariff proposals and her conclusions are ambiguous; she finds that cap-and-trade and carbon tariffs might have a variety of either positive or negative (and hence unpredictable) effects on subsequent negotiating positions. As a result, although the article recognizes the potential for industry response to regulation to influence international negotiations, it does not provide much theoretical or empirical predictive clarity in terms of how or when this will occur. It also focuses more heavily on the issue of leakage as a key mechanism than my research does.

Meanwhile Durkee[87] explicitly suggests a feedback loop logic operating at the level of international treaty making and regulation: a process she terms "regulatory persuasion," in which shifts in interest may feed back into policymaking, in "a chain of responsive persuasive moves, between industry and state actors across national borders".[88] Durkee's analysis largely focuses on two mechanisms: *technical innovation* catalyzed by early regulation (innovation lowers costs and hence industry resistance); and *unilateral regulation* (unilateral regulations create non-tariff barriers that change industries' incentives, causing them to seek out regulatory regimes that improve their competitive environments, i.e. by leveling the regulatory playing field – Vogel's argument above). Durkee's analysis, which derives from globalization literature, is a useful start. But as I will address in greater depth in later chapters, a broader and deeper empirical analysis

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[84] Benedick, *Ozone Diplomacy: New Directions in Safeguarding the Planet*; Durkee, "Persuasion Treaties"; Thoms, "A Comparative Analysis of International Regimes on Ozone and Climate Change with Implications for Regime Design."

[85] Brewster, "Stepping Stone or Stumbling Block: Incrementalism and National Climate Change Legislation"; Urpelainen, "A California Effect for International Environmental Externalities?".

[86] Brewster, "Stepping Stone or Stumbling Block: Incrementalism and National Climate Change Legislation."

[87] Durkee, "Persuasion Treaties."

[88] Ibid., 58.

suggests that these two mechanisms are not the most fundamental mechanisms driving the policy-industry feedback whose presence or absence is crucial to the outcomes of ozone and climate negotiations. More important is a fundamental restructuring of concrete industry interests; for instance in the form of major shifts in capital investment. Processes such as innovation and unilateral regulation change the incentive structure *around* firms; fundamental restructuring of investment changes firms' *inherent* material interests. The latter is the baseline requirement for major shifts in domestic negotiating positions.

Work at the domestic level of analysis offers a somewhat richer field of examples of analysis that identifies policy-industry feedback in some form. There is a set of case studies of the evolution of energy policy that are embedded in the path dependence tradition.[89] As noted above, my colleagues and I introduced the green spiral concept of policy-industry feedback in *Can Green Sustain Growth? From the Religion to the Reality of Sustainable Prosperity*.[90] Our work examined the concept and explored feedback loops in the context of cases such as Denmark, California, and China, finding that it was present in one form or another in several success cases.[91] Eric Biber's work, specifically his paper on California's Proposition 23[92] battle, likewise persuasively develops the theory and empirics of policy-industry feedback dynamics. Biber's argument considers how prior policy created an interest landscape in which Proposition 23 could be defeated; focusing on state and national-level politics, he makes the argument that history matters in creating interest landscapes.

Otherwise, most of the path dependence literature is not situated in or directly relevant to the realm of international negotiation. But a brief look at several domestic-level cases (see Chapter 5) allows me to address this literature as well and make some useful contributions. I summarize these in my Conclusion (Chapter 6).

In sum, then, this project proposes a mechanism, based on policy-industry feedback mechanisms, that explains treaty making outcomes across and within two major cases and fills a gap left by existing theory of international treaty making. Touching on domestic-level cases and literature, this project also makes a contribution to existing literature there on theories of policy-industry feedback, path dependence, and domestic energy policy. In the following three chapters I explore the ozone and climate cases in depth, and draw out an empirical basis for my proposed mechanism, as well as a set of concrete policy implications.

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[89] Aklin and Urpelainen, "Political Competition, Path Dependence, and the Strategy of Sustainable Energy Transitions"; Foxon, "A Coevolutionary Framework for Analysing a Transition to a Sustainable Low Carbon Economy"; Jacobsson and Bergek, "Transforming the Energy Sector: The Evolution of Technological Systems in Renewable Energy Technology"; Stenzel and Frenzel, "Regulating Technological Change - the Strategic Reactions of Utility Companies towards Subsidy Policies in the German, Spanish and UK Electricity Markets."

[90] Kelsey and Zysman, "The Green Spiral"; Zysman and Huberty, *Can Green Sustain Growth? From the Religion to the Reality of Sustainable Prosperity*.

[91] Kelsey and Zysman, "The Green Spiral"; Chang and Gao, "China: Green Industry Growth in a Brown Economy"; Kelsey et al., "The United States: Local Green Spirals, National Ambiguity"; Nygård, "Denmark: A Classic Case of a Green Spiral."

[92] Proposition 23 was a California proposition that would have effectively killed California's AB32 climate change legislation.

CHAPTER 3: OZONE NEGOTIATIONS AND THE GREEN SPIRAL

INTRODUCTION

I will argue in this chapter that the evidence found in the case of the multi-round international ozone negotiations strongly supports the presence of a green spiral, the policy-industry feedback spiral proposed in Chapter 1. I will argue specifically, that the evidence satisfies the criteria laid out in that chapter for a satisfying "missing factor" theoretical component. Moreover, it does so more fully than previously proposed explanations.

In examining the evidence from this case, I will show a set of components of the green spiral. I will show that initial treaty making moves trigger subsequent shifts in industry investment and strategy; that these shifts in investment and business models create shifts in industry interests, which are expressed in changes in industry influence on policymakers; and that increases between negotiation rounds in the political viability of increasingly stringent regulatory agreements follow and reflect changes in industry interest configuration during those periods.

In addition, I will argue that the green spiral mechanism satisfies the criteria for a useful theoretical tool laid out in Chapter 2. The mechanism explains national-level shifts in negotiating positions over time, and it is these shifts, in aggregate, that then explain the overall outcome (success) and pace (generally accelerating over time, with some exceptions around specific issue areas) of the international negotiation process. Hence, as promised, the mechanism *explains the outcome and character of the international process*, as well as the *variation in behavior seen at the national level*. Moreover, as I will lay out, it does so *more fully* than previous explanations advanced, such as knowledge formation and networks; knowledge-based feedback in the form of innovation, research and development; and epiphenomenality.

The rather complex ozone story requires some background to understand. I begin with a brief summary of the ozone depletion problem, followed by a more specific review of the types of evidence one would expect to see in this case if the proposed policy-industry feedback spiral were at work. Next, a brief overview and timeline of the case gives an overall sense of the sequential and interlaced nature of the shifts in policy and in industry, supporting my general argument for a feedback process. I will then discuss in greater detail key points of evidence that demonstrate the presence of specific components of the green spiral. Finally, I will discuss the proposed mechanism's merit relative to alternate explanations put forward to date in the literature.

CHARACTERISTICS OF THE OZONE CASE

Ozone Depletion

Ozone depletion is caused by a set of chemicals, collectively known as ozone depleting substances (ODS). The best-known class of ODSs is chlorofluorocarbons (CFCs), but other compounds containing halons (chlorine or bromine) have been identified as ODSs as well. When ODSs rise into the atmosphere, UV light breaks them apart, releasing their

halon atoms. These atoms act as catalysts to break apart ozone molecules, destroying ozone. Since the halogen atom is not consumed when it acts as a catalyst, it remains active in the atmosphere for some time. Hence a small amount of ODS can destroy a large amount of ozone.

Ozone depletion can be observed both as overall thinning of the ozone layer surrounding the earth; and in the formation of an ozone "hole" in the Antarctic stratosphere[93], where local conditions enhance ozone catalysis and create particularly pronounced depletion during spring. Modelers did not initially predict the Antarctic "hole"; its recognition in the mid-1980s was one of the factors that led to increased public concern around the problem of ozone depletion.

Ozone depletion matters because the ozone layer protects the earth's surface from some forms of ultraviolet light (specifically UVB). UV light causes skin cancer and eye damage in humans, so thinning of the ozone layer constitutes a major global health threat. Increased UV radiation could also have other harmful effects, such as damage to crops.

Public Policy History

The potential for dangerous ozone depletion became widely recognized in the 1970s, after the publication of a seminal study on the problem[94]. However, initial interest in the problem waned in most countries as investigation did not immediately produce initially compelling evidence of damage. It was not until the mid-1980s that advancing scientific knowledge and recognition of more intense local effects such as the Antarctic ozone hole revived serious international concern and kicked off a multi-round, multilateral negotiation process to create international regulation to control the emission of ODSs.[95]

The multi-round negotiation process took place under the auspices of the Vienna Convention for the Protection of the Ozone Layer,[96] the product of negotiation at the Vienna Conference in 1985. The Vienna Convention itself was politically toothless, placing no regulatory requirements on countries' ODS usage. However, it provided the framework for subsequent negotiations. Rounds of negotiation occurred regularly thereafter, with the most important rounds being Montreal (1987), London (1990), and Copenhagen (1992). In seven years – between 1985 and 1992 – the international community created and tightened a set of agreements that enforced substantial and effective levels of emissions reductions under rapid phase-out schedules for CFCs and other chemicals found to deplete ozone.

The ozone negotiations are broadly seen as a major success and an exemplar of how to "do environmental negotiation right." Both their overall success and the rapid and

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[93] Although there is some increased depletion at the Arctic pole as well, it is not as pronounced.

[94] Molina and Rowland, "Stratospheric Sink for Chlorofluoromethanes: Chlorine Atom-Catalysed Destruction of Ozone"; interestingly, although specific concern for the ozone layer is generally dated to Molina and Rowland's publication in 1974, Du Pont, ICI, and other producers were concerned about environmental impacts of vented CFCs as early as 1972. (Powell, "Fluorine Chemistry: The ICI Legacy," 357).

[95] Benedick, *Ozone Diplomacy: New Directions in Safeguarding the Planet*, 14–18.

[96] "Vienna Convention for the Protection of the Ozone Layer."

accelerating pace at which the cut-backs proceeded are noteworthy, particularly given that the process began with most players resistant to significant regulation.

The Major Players

Only a few countries produced ODSs in significant quantities at the time of negotiation. Although the question of how to prevent CFC production leakage to developing countries was considered throughout, and reduction/prevention of ODS use in developing economies became increasingly important in later rounds, there was clearly a small set of key producer countries that were core to the negotiations throughout. The most critical were the United States and Europe, with Europe's position mostly dictated by the trio of the UK, Germany, and France. Japan was important but rarely appears to have acted as a critical swing vote, as it was mostly concerned about protecting its semiconductor industry (a major user of CFC-113) and hence satisfied with arrangements that allowed it flexibility about how to meet reduction requirements.[97] The USSR/Russia's most critical concerns (over production capacity already planned) were satisfied with a single grandfather clause in the first major regulatory round (Montreal).[98] In practice, regulatory outcomes are well explained by aggregating the positions of the US, UK, Germany, and France. Therefore much of my analysis will focus on the developments in these countries, though I summarize developments in Japan as well.

The key national players were dictated by the locations of the major CFC producers. The CFC industry was quite concentrated; a large percentage of CFCs were manufactured by a few key producers:

- **DuPont** (and to a lesser extent **Allied-Signal**) in the United States
- **Imperial Chemical Industries (ICI)** in the United Kingdom
- **Atochem** in France
- **Hoechst** in Germany

There were also a set of secondary industry players: Pennwalt, Racon, and Kaiser (US); Montefluos (Italy), Showa Denko, Daikin, and Asahi Glass (Japan); the nationalized industries of the USSR/Russia; and a few other bit players.

OBSERVABLE IMPLICATIONS OF THE PROPOSED FEEDBACK MECHANISM:

In essence, the green spiral is a set of temporally sequenced shifts in industry and policy that show co-evolution, with each phase having a causal relationship to the subsequent phase. How will we know this mechanism when we see it? Briefly, what we are looking to see is 1) whether we observe a temporally sequenced series of phases, as suggested by the mechanism; 2) whether we observe evidence consonant with mechanisms by which causal influence could plausibly have occurred, such as changes to observable industry influence pathways; 3) whether shifts in national industry evolution match subsequent observed shifts in national policy position in a nuanced way; and 4) whether an observed *absence* of indicators for industry evolution correlates with an observed *absence* of subsequent shifts in policy viability.

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[97] Benedick, *Ozone Diplomacy: New Directions in Safeguarding the Planet*, 78–79.

[98] Ibid., 82–83.

In greater detail, we should expect to observe some or all of the following:

1) ***Temporally sequenced phases of policy-making and industry reconfiguration***. The presence of these fundamental components of the spiral mechanism is a basic requirement for us to believe that the mechanism could be at work. They include:
   a. *Initial policy moves:* initial regulatory shifts, the result of international negotiation.
   b. *Subsequent industry response to policy moves*: industry shifts investment and behavior in ways responsive to initial policy moves. One particularly important form of response is investment in production facilities for non-polluting substitutes; *sunk costs in capital investment* are a loss if substitutes are not ultimately adopted, so capital investment creates interests in substitute-supporting regulation. Other forms include shifts in business structure, such as creation of new branches of business or sunsetting of old ones, representing *sunk costs in organizational and strategic effort* and *abandonment of old sunk capital investment costs*; public pledges to shift business strategy, i.e. to phase out polluting products on explicit, near-term schedules, which represent *sunk costs in reputation*; and perhaps investment in research and development (R&D) for new products[99].
   c. *Changes in regulatory outcomes in the next round of negotiation:* We observe changes in the range of politically viable regulatory outcomes in the next negotiation round, which are *consonant with prior shifts in industry interests*. Regulatory outcomes in the second round differ from the first round in ways that make sense given prior shifts in industry.
   d. *Optionally, continuation of the process through multiple rounds*: The process described above may continue through multiple rounds of iteration, with responses to each new round acting as the seeds for the next.

2) ***Evidence consonant with reciprocal causality***. Fully proving causal connections between policy moves and industry shifts, and vice versa, is difficult, since these are complex phenomena with decision-making processes that are far from transparent. However, we should see observe behavior that is at least consonant with a reciprocal causal relationship between the two.
   a. *Industry moves result from policy moves.* We would expect to see tangible changes to industry behavior that are attributed by knowledgeable contemporaries to policy moves and appear unlikely to have happened in absence of those moves.
   b. *Industry can be seen to influence policy positions of nations*. We would expect evidence that industry had influence over policymakers' decisions in setting

[99] This last factor is a darling of the existing literature and it is important as an *enabling* factor; industry cannot shift to substitutes if no substitutes are technically feasible. As a mechanism for shifting industry interests, however, it is probably not very important. R&D costs are generally much lower than major capital investment costs. Moreover, businesses expect that not all R&D spending will pay off. In fact, industry went pretty far down the path of substitutes development during the 1970s, but largely suspended that work when regulatory pressure failed to materialize in the early 1980s. The substitutes were only revived when regulatory pressure rematerialized. (Powell, "Fluorine Chemistry: The ICI Legacy.")

national negotiating positions – for instance, in contemporary assessments of policy decision-making.

c. *The direction of industry influence on policymakers changes in accordance with industry interests*. We would expect evidence of changes in the influence exerted by industry on policymakers that are consonant with changes to potentially viable policy**.** Shifts in industry pressure can happen in a variety of ways: reduced anti-regulation lobbying; increased pro-regulation lobbying; actions that assist the expansion of domestic or international regulation, such as industry pledges to cut back production or to assist in transferring technology to less developed countries; positive participation in epistemic communities, helping to achieve and transmit consensus rather than resisting it; and other mechanisms.

3) Fine-grained correlation at the national level between national negotiating positions and results of national industry responses. If nuanced differences between industry evolutions across different nations correlate to nuanced differences in national position within a given round of negotiation, that would provide particularly suggestive evidence for the presence of the proposed mechanism. This affects:

a. *Overall position on regulation*: Movement in country negotiating positions should be observed where shifts in national industry interests have occurred, and not where they have not.

b. *Form of regulation favored*: In cases where choices exist over the form or scope of regulatory treaty outcome, countries should be observed backing forms that best suit the contemporary evolution of their national industries.

4) ***Lack of industry evolution is correlated with absence of policy evolution***. Sometimes novel issue areas are raised late in negotiation, as when new chemicals are discovered to be relevant pollutants. These issue areas should theoretically benefit from external factors such as the development of epistemic communities and the dissemination of knowledge. But they will typically not have benefited from a prior process of policy-industry feedback like those affecting other areas dealt with in prior negotiation rounds. We would expect these novel issue areas to be much less permissive to strong regulatory outcomes than issue areas that have undergone prior policy-industry evolution, and finding evidence of this difference would be strongly suggestive that the proposed mechanism is an important causal factor.

Below, I present a brief overview of the timelines and outcomes of the multi-round ozone negotiations. The brief overview should begin to show the generally sequential nature of shifts that I described above – from treaty outcome to industry to treaty outcome, and so on. In the section following, I will then dig more deeply into some specific points of evidence that speak to the feedback nature of the process as described.

BRIEF OVERVIEW AND TIMELINE OF THE CASE

Ozone negotiation proceeded in a series of phases, each culminating in a round of formal treaty making and a formal agreement – in Vienna in 1985; Montreal in 1987;

London in 1990; and Copenhagen in 1992 (negotiations continued but are less interesting after 1992). In addition to orienting the reader to the timeline of the case, this section demonstrates the overarching temporal sequencing that I discuss above. The initial policy moves in the Montreal Protocol triggered a partial reconfiguration of industry interests, leaving industry more tolerant of increased regulation. This made increasingly stringent regulation of CFCs in the London round viable. Between London and Copenhagen, industry fully reconfigured itself around CFC substitutes, allowing for even more stringent regulation at Copenhagen.

Following this overview, I will focus more specifically on key points of evidence for the proposed feedback mechanism.

Phase 1: Pre-Vienna, the Vienna Convention, and Vienna to Montreal (1970s - 1987)

From the initial characterization of the ozone problem up to 1985, concern over ozone depletion was most concentrated in the United States and a handful of relatively small northerly countries. Of the major players, only the US imposed significant domestic regulation. The political "heavy hitters" of Europe – the United Kingdom, France, Germany – were all CFC producer hosts and were all generally opposed to regulation of CFCs, with the UK tending to lead the resistance and France content to let it do so.[100] The EC had placed controls on aerosols, but at levels considered weak enough to be essentially toothless; other measures proposed at the time failed.[101]

The 1985 Vienna Convention created a negotiation forum, but, reflecting majority resistance to regulation at the time, it did not impose any actual ODS controls. As a result, industry interests stayed relatively static immediately following Vienna. The one major change was Germany's shift to a pro-regulation stance in 1986 – possibly the only major shift in these negotiations that does not clearly mirror shifts in material interests. Germany's political configuration uniquely privileges its green political wing. When green political groups in Germany became focused on ozone as an issue, they were able to swing consumer and political behavior rapidly and without industry cooperation. Germany's negotiating stance became strongly pro-regulation in 1986, partially shifting the balance of power.

Phase 2: The Montreal Protocol (1987)

Negotiation in Montreal in 1987 yielded the Montreal Protocol, the first major international regulatory move. The protocol reflected the mix of interests described above. Germany's 1986 shift meant that sufficient pro-regulatory weight existed, in concert with institutional shifts in the governance of the European Community, to produce a treaty that required specific mitigation measures. However, enough opposition remained that the regulatory measures agreed upon were fairly moderate: a freeze on core CFCs with a partial phase-out (50%) over 10 years, and a freeze on halons starting in 1992.[102]

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[100] Benedick, *Ozone Diplomacy: New Directions in Safeguarding the Planet*, 38.

[101] Haigh, *EEC Environmental Policy and Britain*, 266; Jachtenfuchs, "The European Community and the Protection of the Ozone Layer," 263.

[102] "Montreal Protocol Article 2."

Phase 3: Montreal to London (September 16, 1987 – June 27, 1990)

The creation of the Montreal Protocol meant that industry now faced concrete phase-out schedules for production of CFCs. Industry reacted in a variety of ways. None of the major players ignored the Protocol entirely; all took some steps toward commercialization of substitutes. But the level and type of activity varied by company.

Company activity varies along two dimensions. First, *pace of action*: did a company make aggressive early investments, or did it invest moderately or weakly? New product development typically proceeds along a predictable trajectory with a set of milestones: 1) research and development (R&D); 2) pilot production; 3) planning/design for commercial-scale production; 4) construction of initial commercial-scale production facilities; and 5) expansion to larger and/or multiple facilities. Substantial capital investment occurs during steps 4 and 5. Between Montreal and London, potential substitutes were still undergoing safety testing; companies that broke ground on or completed commercial-scale facilities during this period (hence incurring sunk costs) were making aggressive, even risky, investments.

Second, *type of investment*: did the company focus on intermediate substitutes (HCFCs, with weaker but non-zero ozone depletion potential (ODP), which faced the potential for regulation if regulation became stringent enough), on full substitutes (such as HFCs, with zero ODP), or on both? To some extent, this represented a trade-off between long-term and short-term costs and benefits. Partial substitutes were better known and could more readily fill the gap, but were likely to be phased out eventually; full substitutes were expensive and not as well-developed, but offered a long-term business.

Below, I describe company reactions, grouped by country.

Table 2: Industry Investment Patterns by Country, Montreal to London

Country	Full Substitutes	Partial Substitutes
United States	***Aggressive***	***Moderate to Aggressive***
United Kingdom	***Aggressive***	Weak
France	Weak	Moderate
Japan	Weak	Moderate
Germany	Weak, but anomalous	Weak, but anomalous

United States

In the United States, DuPont was the clear market leader and strongest policy influence. Allied-Signal was a somewhat distant second. Pennwalt was a minor player, bought by Atochem toward the end of this period. Other firms were largely unimportant.[103]

Between Montreal and London, DuPont invested across both full (HFC) and partial (HCFC) substitutes – but most aggressively in full substitutes. DuPont started multiple pilot

[103] Third-tier players Racon and Kaiser had only 6% of the US market each as of 1987. (Goldbaum et al., "A Treaty to Ground CFCs May Push Prices Upward.")

facilities for both.[104] DuPont actually broke ground on two larger commercial-scale production facilities (HFC-134a and HCFC-123) well before the London meeting[105]; its HFC-134a facility was completed not long after the meeting, in September of 1990[106]. These facilities alone represented over $50 million in investment[107]. Funds for an additional world-scale HFC-134a facility were authorized by June 1990, just prior to the London talks, as part of a package of four plants to be built in the US, Europe, and Japan, to produce HFCs-134a, 152a, and 125[108]. By the opening of the negotiations in London, the US's lead negotiator understood DuPont to have invested nearly $250 million on development of substitutes already, and to be envisioning a $1 billion program[109].

Meanwhile, Allied-Signal was a more moderate investor, with a focus on partial substitutes. It was piloting HCFC-123 and HCFC-141b by 1988[110], and HFC-134a by 1989;[111] it signed a joint R&D agreement with Atochem on these substances, although this agreement fell apart by the London talks.[112] Allied focused on HCFC-141b, with plans for a $50 million commercial-scale 141b plant announced by late 1989 (ground was not broken before London), and HCFC-141b-based products under development[113].

United Kingdom

ICI, the major CFC producer in the U.K., made investments that were both aggressive and almost entirely focused on full substitute HFC-134a. Like DuPont, ICI broke ground on an HFC-134a plant well before the London meeting and had it completed not long after the meeting, at an estimated cost of **£**30 million ($58.5 million)[114]. By late 1989 ICI also announced plans for another HFC-134a plant in the US, at more than $100 million, in process by 1990[115]; it was also considering additional plants abroad.[116] ICI was less active in partial substitutes[117].

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[104] MacKerron, Lazorko, and Hunter, David, "How Long a Farewell to CFC Production?"; "Du Pont Producing CFC Replacement"; "Du Pont Developing CFC Alternatives"; "Du Pont Facility to Make CFC Alternatives."

[105] Darst, "Du Pont to Begin Production of Substitute for Ozone-Destroying Chemical"; Journal of Commerce Staff, "Du Pont Oks Alternative CFC Production Funding"; Maggs and Journal of Commerce Staff, "ICI Plans to Set up Plant in US for CFC Substitute"; Wire and Staff Report, "Du Pont's Canada Unit to Make CFC Substitutes."

[106] "Du Pont Completes Construction of Plant for CFC Alternative."

[107] Ibid.; Geddes, "Du Pont to Make CFCs Substitute."

[108] "Du Pont Okays Funds for CFC Alternative Plants."

[109] Ibid.; Benedick, *Ozone Diplomacy: New Directions in Safeguarding the Planet*, 165.

[110] MacKerron, Lazorko, and Hunter, David, "How Long a Farewell to CFC Production?".

[111] "Pilot Plant for CFC Substitutes."

[112] "Allied-Signal and Atochem to Announce Agreement"; "Allied, Atochem Dispute HCFC-141b."

[113] "Allied-Signal to Build CFC Substitute Plant in Louisiana"; Rothman, "Getting CFC Substitutes to Market."

[114] "ICI Startup."

[115] Ibid.; Maggs and Journal of Commerce Staff, "ICI Plans to Set up Plant in US for CFC Substitute."

[116] Hunter, "ICI Focuses on Leading-Edge R&D."

[117] "ICI Goes Ahead on HCFC-123."

ICI also significantly shifted changed business strategy, organizational effort, and planning relatively early on. By 1988 companies in the UK voluntarily agreed to give up CFC-based aerosol propellants.[118] This was not strictly necessary under the Protocol, and may have been in response to increasing competitive pressure from non-CFC aerosol products produced by US companies.

ICI was not at this point an unalloyed supporter of regulation; much of its publicity materials at the time continued to question the scope and certainty of the ozone depletion problem, and at least as late as March 1988 it was still against *acceleration* of phase-out.[119] But internally it was taking aggressive steps to shift its core business. By late 1988, the UK already expected to meet 50 percent reduction targets (largely from aerosol reductions) a decade ahead of schedule.[120]

France

Atochem, the major CFC producer in France, made fairly weak initial investments in substitutes, especially full substitutes. By London, Atochem was still in piloting and planning phases for 134a, planning to modify an existing facility and bring production online in 1992[121]. Contemporaries perceived Atochem as generally moving slowly on substitutes; Benedick writes, "French commentators observed that… Atochem, rather than expanding research into CFC substitutes, 'seems to prefer to deploy most of its efforts toward maximum use of exceptions provided for by the Protocol.'"[122] It may have been exploring transfer of CFC production abroad.

Atochem's most significant moves were acquisitions of American companies Racon (January 1989) and Pennwalt (late December 1989)[123]. Pennwalt gave Atochem a position in a partial substitute HCFC-141b, via a $30 million conversion of a Pennwalt plant. Mass-production of 141b began in December of 1990, several months after London, and was likely under conversion during the talks. However, these acquisitions also increased Atochem's holdings in production capacity for CFCs and HCFC-22, a partial substitute with a relatively high ODP.[124]

Japan

Japanese company investment was moderate to weak across full and partial substitutes. Showa Denko was piloting HFC-134a by June of 1988 and had plans for a commercial-scale plant.[125] Asahi Glass had a small-lot facility for HCFC-123, which could

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[118] Benedick, *Ozone Diplomacy: New Directions in Safeguarding the Planet*, 107.

[119] Ibid., 103; Jordan, "The Ozone Endgame: The Implementation of the Montreal Protocol in the United Kingdom," 32.

[120] Jordan, "The Ozone Endgame: The Implementation of the Montreal Protocol in the United Kingdom," 34.

[121] Chynoweth, "Industry Gears up for Phaseout."

[122] Benedick, *Ozone Diplomacy: New Directions in Safeguarding the Planet*, 103.

[123] Hunter, David, "Atochem Bets on CFC in 1990s"; Arkema Inc., "Arkema Inc. History (1970-1980)."

[124] Hunter, David, "Atochem Bets on CFC in 1990s."

[125] "Showa Denko Makes CFC 12 Substitute."

be increased to commercial-scale.[126] The end-user market is particularly relevant in Japan: during negotiation Japan was particularly concerned with the fate of CFC-113, used in the processing of electronic components. Between Montreal and London, CFC-113 recycling technology was advancing and electronics companies were actively seeking non-CFC alternatives and recycling strategies, curtailing the value of the future CFC-113 market and reducing the threat to Japan's future semiconductor production.[127]

Germany

Germany's uniquely strong green politics meant that Hoechst, the major German CFC producer, was unable either to defend its legacy CFC business or move aggressively on substitutes. As late as 1987, Hoechst was a leader in a CFC producer group lobbying for very limited CFC controls.[128] But in 1987 and 1988, Hoechst saw an 85% decline in CFC sales.[129] CFCs were clearly a losing proposition in Germany – the West German government announced a unilateral 95% reduction goal by 1988[130] – and Hoechst began planning to phase out CFCs entirely by 1995, well ahead of regulations.[131] By 1990, Hoechst made little *concrete* investment, although it discussed tentative plans for various full substitute plants.[132] But this was in fact a signal of green political power: environmental groups also had concerns about substitutes. Hoechst couldn't invest until the government clarified restrictions and issued permits for new factories, and testing of potential substitutes was completed.

Phase 4: The London Amendment (June 27-29, 1990)

The amendment agreed upon in London reflected a shift in balance of power toward more aggressive regulation, which ran in parallel to shifts in domestic interests. Montreal played out as a coalition of the US and Germany (with Canada and some smaller European players) on the pro-regulation side, against the UK, France, Italy, and other anti-regulation countries. By the London talks, the UK had swung from the anti- to the pro-regulation side. This shift has typically been attributed to recognition by the British of increasing evidence for the loss of ozone.

However, the updated configuration of country positions entering the London meeting tracks well with what we would expect simply from looking at the shifts in domestic industry interest configurations. The UK, where industry invested aggressively, made a significant shift in position to supporting regulation. France's industry was making moderate to weak movements toward substitutes, with its strongest efforts in partial substitutes; France remained relatively resistant to regulation.

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[126] "Asahi Glass to Mass Produce Artificial Substitute for Ozone-Destroying Gas."

[127] Benedick, *Ozone Diplomacy: New Directions in Safeguarding the Planet*, 79; Woo, "Summit to Highlight Japan's Role in Ozone Protection."

[128] "Reduction of Chlorofluorocarbons Output Is Sought."

[129] "Hoechst Pretax Earnings up despite CFC Sales Downturn."

[130] Benedick, *Ozone Diplomacy: New Directions in Safeguarding the Planet*, 113.

[131] "Hoechst Announces Intention to Cease CFC Production by 1995."

[132] Ibid.; "Bosch-Siemens Develops CFC-Free Polyurethane Foam Technology."

The UK's swing toward regulation left it allied with the more hawkish Germany, and left France's resistance isolated (Spain was reportedly also in opposition but was not a key producer).[133] As a result, the EC as a whole shifted from relatively conservative to relatively hawkish on ozone regulation. The US was actually slightly more moderate at this point, joining the EC in advocating full phase-out by the end of the century, but favoring more time on interim reduction targets[134]. With both the US and the EU hawkish on regulation, the result was a tightened phase-out schedule for CFCs, with tougher interim targets (reduction to 50% by 1993; 15% by 1997) and full phase-out in 2000. Halon regulation was also tightened, with phase-out also set for 2000.[135]

Some new issues came to the fore in this round. Methyl chloroform and carbon tetrachloride, new ODSs, were regulated. The issue of the ozone depleting potential of HCFCs (partial substitutes) was raised: HCFCs were cataloged in a treaty annex but no phase-out targets set. Funding and technology transfer for developing nations was agreed to, and a technology transfer failsafe was negotiated.

Phase 5: London to Copenhagen (June 1990 – November 23, 1992)

Industry activity following London increased in pace and scope. By Copenhagen, *all* major players (except Hoechst; see below) had significant sunk capital investment in commercial-scale production facilities. These typically included both full and partial substitutes (ICI in the UK and Hoechst in Germany focused on full substitutes alone). Moreover, the substantive interests CFC producers had in legacy CFC production dwindled rapidly. By 1991 and through 1992, companies were shutting down these facilities and hence relinquishing their sunk costs.[136]

Table 3: Industry Investment Patterns by Country, London to Copenhagen

Country	Full Substitutes	Partial Substitutes
United States	***Aggressive***	***Moderate to Aggressive***
United Kingdom	***Aggressive***	Little or None
France	Moderate	***Aggressive***
Japan	***Moderate to Aggressive***	Weak
Germany	Weak, but anomalous	Little or None

United States

DuPont continued aggressive investment in full substitutes. Having already completed its first HFC-134a plant in September of 1990, it initiated at least six others. By

[133] Benedick, *Ozone Diplomacy: New Directions in Safeguarding the Planet*, 115.

[134] This is likely due to the moderating influence of the US CFC end user markets: the US had strong appliance industries – such as refrigeration manufacturers – that were concerned about whether they could adapt to unfamiliar substitutes quickly enough.

[135] "London Amendment to the Montreal Protocol."

[136] Brown, "ICI Advances CFC Plant Closure"; Chynoweth, "Atochem and Montefluous Agree on Cutbacks, Supply Deal"; Chynoweth and Hunter, "CFC Makers Forge New Ties."

the Copenhagen meeting, it had completed two (in New Jersey and Japan), had another under construction (Texas, a $100 million investment), and had three more in the planning and design phase (in Kentucky, Oklahoma, and the Netherlands).[137] By 1992 DuPont was publicly signaling disappointment with the growth in demand for HFC-134a; one official noted explicitly that a speeded CFC phase-out would spur demand.[138] During this period, DuPont also began early commercialization of second-generation full substitutes HFC-32 and HFC-143a.[139]

DuPont also continued efforts in partial substitutes, more moderately. It completed the HCFC-123 plant it had already begun, and started up the plant in early 1991.[140] A plan for an HCFC-141b plant[141] does not seem to have born fruit; by 1992 Chemical Week was reporting that DuPont had "shied away" from HCFC-141b.[142]

Allied-Signal, meanwhile, pushed ahead with partial substitute HCFC-141b. It obtained permission from the EPA to build a commercial-scale 141b plant in August 1990,[143] but in 1991 shifted to conversion of an existing facility, which opened February 1992.[144] Allied also began work in full substitutes. In March of 1992 it announced plans for a $40 million flexible, multi-product HFC-134a plant in Louisiana, expected online in 1994[145]. Allied announced in September of 1992 that the same plant would produce full substitutes HFC-32 and HFC-143a as well as HFC-125.[146]

United Kingdom

ICI remained a leader in the full substitute HFC-134a, and essentially abandoned partial substitutes. ICI had already completed a commercial-scale HFC-134a plant by late 1990, and broken ground on another in the United States, which it ultimately commissioned before the Copenhagen round, in October 1992.[147] ICI initiated a third plant in Japan (in a joint venture with Teijin) in spring 1992.[148] ICI considered an additional world scale plant in Europe; but was also expressing concern about the fact that the market for HFC-134a was not growing as fast is it had expected.[149] In fall 1992 ICI developed a catalyst that doubled production of 134a at existing sites, and delayed

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[137] "Du Pont Announces Commercial Availability of CFC Alternatives"; "Du Pont Authorizes World's First Commercial-Scale Plant for HFC-125"; "Du Pont Okays Funds for CFC Alternative Plants"; "Japanese HFC-134a Plant Is Ready"; Morris, "Texas Looks to Build Downstream"; "Technology Boosts Du Pont's HFC-134a Plans."

[138] Rotman and Kiesche, "Pressure Builds on CFC Substitutes."

[139] "Du Pont Announces Commercial Availability of CFC Alternatives"; "Du Pont Starts up HFC-32 Plant."

[140] "Du Pont Announces Commercialization of CFC Refrigeration Alternatives."

[141] Flam, "The Pace to Replace CFCs Quickens."

[142] Rotman and Kiesche, "Pressure Builds on CFC Substitutes."

[143] "Allied Gets OK on HCFC-141b."

[144] "Allied-Signal's Response to Bush's CFC Phase out Plan."

[145] "Allied-Signal Announces Plans for Production of CFC Substitutes in Baton Rouge, LA."

[146] "Allied-Signal Expands Alternative Ambitions."

[147] Chynoweth, "ICI Improves HFC-134a Catalyst, Doubles Output."

[148] Chynoweth, "ICI and Teijin Will Build Joint HFC Capacity in Japan."

[149] Alperowicz, "ICI to Build New European HFC-134a Unit."

additional plant plans.[150] ICI did push ahead with the second-generation full substitute, HFC-32, opening a £4 million pilot plant by 1992 and expanding capacity in July 1992, though it did not proceed to full commercial scale prior to Copenhagen.[151] ICI was essentially inactive in the partial substitutes market at this point, abandoning efforts in HCFC-123 when some ambiguous preliminary safety testing results were released in mid-1991.[152]

France

After London, Atochem aggressively invested in the partial substitute HCFC-141b. Atochem already had one commercial-scale HCFC-141b/142b plant, derived from the Pennwalt acquisition and plant conversion. It made several capacity expansions to its HCFC-141b/HCFC-142b plant in Kentucky, including a second unit, and started up a huge additional 40,000 metric ton/year plant in France.[153] By late 1991, HCFC-141b was taking some heat for its ODP;[154] Atochem, increasingly committed to 141b, issued a statement backing HCFCs as necessary near-term solutions.[155]

Atochem's movement into full substitutes was slower but eventually found traction. Atochem commissioned one fairly large HFC-134a plant just before Copenhagen and was planning another.[156] Atochem also piloted additional full substitutes HFC-125, HFC-143a, and HFC-32.[157] Like Du Pont and ICI, however, Atochem had difficulty with low demand, and did not initially operate its HFC-134a plant at full capacity.

Japan

Japanese CFC producers moved with moderate speed on full substitute production following the London meeting. Showa Denko began building a commercial-scale HFC-134a plant in early 1991, to come online at the end of the year;[158] Daikin and Mitsui-DuPont Fluorochemicals (a joint venture) both completed their own commercial-scale 134a plants before Copenhagen.[159] Daikin also had a pilot-scale plant online for HFC-32 by mid-1992.[160] Officers at Showa Denko expressed concern about oversupply of HFC-

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[150] Chynoweth, "ICI Improves HFC-134a Catalyst, Doubles Output."

[151] Breskin, "ICI Promotes Compound for Coolant Replacement"; "ICI Announces Construction of New Alternative Refrigerant Facility."

[152] Brown, "ICI Pounds 100m Research Produces Ozone-Safe CFC Alternative."

[153] Chynoweth, "Atochem and Montefluous Agree on Cutbacks, Supply Deal"; "Elf Atochem Begins Commercial Production of 143a and Introduces a New Blend to Its Range of 502 Substitutes"; "Elf Atochem Boosts HCFC-141b Capacity."

[154] Although HCFC-141b, like the other HCFCs, had significantly lower ODP than CFCs, it still had some potential to deplete ozone, and appeared to have particularly strong near-term effects when first released.

[155] "Atochem Declares HCFCs Are a Responsible, Short-Term Solution to Protect the Ozone Layer."

[156] Chynoweth, "Elf Atochem Details Three-Pronged CFC Phaseout Strategy"; "Elf Atochem Plans HFC-134a in the U.S."

[157] Rotman, "Elf Atochem Pushes Further into CFC Substitutes."

[158] "Rising to the Challenge with a Spate of New Strategies."

[159] "Daikin Starts HFC-134a Plant"; "Japanese HFC-134a Plant Is Ready."

[160] Chynoweth, "Search for Alternative Refrigerants Heats up."

134a in Japan for the next 2-3 years.[161] Japanese corporations do not appear to have been major players in partial substitutes in the period between London and Copenhagen.

Germany

Hoechst's position in Germany continued to be anomalous; by mid-1990, Germany was moving faster on domestic controls of CFCs and HCFCs than any other major European country. Developmentally, Hoechst focused on full substitutes and avoided partial substitutes,[162] in accordance with German bans on partial substitutes. But the level of concrete investment at this point is unclear – German officials seem to have been slow to give Hoechst permission to build new capacity, even in substitutes[163]. Although the reporting is unclear, Hoechst still did not appear to have any commercial-scale capacity commissioned and in service in Germany[164] by Copenhagen.

Phase 6: Copenhagen (1992)

The outcome of negotiation in Copenhagen was again consonant with the shifts in industry interests observed. By the November 1992 Copenhagen negotiating round, all major CFC producers had significant concrete capital investment in full and/or partial substitutes. They were increasingly concerned about overcapacity and lagging demand, particularly in HFC-134a. Several producers had openly stated that further tightening of the CFC phase-out schedule might be desirable in light of this problem. In negotiation, accelerated phase-out of CFCs, halons, carbon tetrachloride, and methyl chloroform were agreed to with little controversy.[165] France was no longer a significant opponent of CFC controls; indeed, none of the original major players remained clearly opposed to regulation in core issues areas.

Tension between major players remained in two significant areas at this point.[166] Positions on HCFC controls differed, in ways consonant with different domestic industry investment. The round introduced weak HCFC controls, freezing HCFCs at 1991 levels starting in 1995. Second, the novel ODS methyl bromide had been brought into negotiation, and countries were divided on how to handle it. I address both of these issues in greater detail below, in discussion of specific points of evidence for the policy-industry feedback mechanism.

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[161] "Rising to the Challenge with a Spate of New Strategies."

[162] Chynoweth, "Hoechst Pins Its Hopes on HFCs"; "...and Speed CFC Phaseout."

[163] Both full and partial substitutes raised potential environmental concerns of their own. Partial substitutes, obviously, did not entirely remove ozone depletion concerns. Full substitutes raised a separate issue: they had potential as strong greenhouse gases.

[164] It may have had a plant partially converted to HFC-134a in Brazil.

[165] Benedick, *Ozone Diplomacy: New Directions in Safeguarding the Planet*, 203.

[166] Another important negotiating issue in this round was the provision of funding and assistance to the developing countries to assist them in meeting their more generous phaseout schedules. I have not dealt with this issue for reasons of scope; but it is worth noting that by this point in the negotiations, the developed countries were all committed enough to regulation to put in the effort to make sure developing countries were on board – including working out mechanisms and sources for transferring funding and technology.

KEY POINTS OF EVIDENCE FOR THE GREEN SPIRAL

Temporally sequenced phases of policy-making and industry reconfiguration.

In brief, the history of the major rounds of negotiation around ozone depletion presents a strong picture of temporally sequenced phases of feedback and coevolution between treaty outcomes and shifts in industry interest. The Montreal Protocol as an initial policy move triggered shifts in industry investment that split industry interests. A significant proportion of industry developed interests in further regulation or were at least adapted to and tolerant of it, while a minority invested less heavily, and remained guardedly resistant. This partial shift created fertile ground for the tightening of regulation seen in the London Amendments.

After the London Amendments, all major producers made or increased significant capital investments in production capacity for full and/or partial substitutes. All major industry players were thus regulation-adapted, and resulting over-capacity meant that a more moderate phase-out schedule would not grow the market for substitutes as fast as producers needed it to grow to justify sunk investment. In keeping with this further evolution of domestic interest configurations, the major players in negotiations were largely united around increasingly stringent controls of core ODS. By this point, regulation was essentially self-sustaining, except in cases of new chemicals.

Evidence for reciprocal causality between policy shifts and industry shifts.

The case provides good reason to believe that ***there was a causal relationship between the regulatory outcomes of negotiating rounds and subsequent industry responses***. This is easiest to see in the case of the Montreal Protocol. Prior to passage of the Protocol, industry had done substantial substitute R&D, but largely shelved this work during the early 1980s as it became clear that aggressive regulation was not immediately forthcoming, especially in Europe. [167] Only after the Protocol did companies take steps – in some cases quite expensive ones – to actually commercialize these substitutes. Companies could have taken these steps prior to regulation but did not; hence, they appear unlikely to have been taken in absence of such regulation. The outcome of the second round of negotiation in London also appears to have accelerated the developmental pace of relative laggards like Atochem in France.

Industry interests also appear to have causal influence on countries' negotiating positions. *Correlations between industry positions and negotiating positions* are demonstrated throughout, with regard to both the United States and the Member States of the EC. Typically states' positions in ozone negotiations did not significantly exceed their home industries' interests (the exception is Germany after 1986; as noted, Germany's

[167] ICI, for instance, began work on CFC substitutes around 1974; by 1975-1976 it had identified the full substitute HFC-134a as a particularly promising substitute – which indeed it was – and began working on process pathways for its production. In the early 1980s, however, as urgency on CFC control receded and "the potential market which ICI had anticipated for 134a disappeared", ICI shelved its development program, though it retained its pilot facility. (Powell, "Fluorine Chemistry: The ICI Legacy," 358-360.) Similarly, US industry was also not far from commercialization but unwilling to commit further funds in absence of incentives. (Benedick, *Ozone Diplomacy: New Directions in Safeguarding the Planet*, 53.)

political and social structure gives unusual weight to environmental constituencies). In the pre-Montreal period, for instance, the EC's toothless regulatory legislation was largely dictated by industry position. Nigel Haigh[168] suggests the toothless EC regulation of the period was chosen because it could be easily achieved by industry and because more stringent regulation "would be likely to cause socio-economic problems because of existing overcapacity of industry." The EC's early position on regulation was thought to be heavily influenced by the UK's opposition to regulation; the UK's opposition in turn was thought to be a result of pressure from ICI, the largest EC producer at the time.[169]

Similarly, during the Montreal negotiations, country negotiating positions generally accorded with and rarely went beyond their home industry's interests. The US was a leader in ozone regulation not simply because of public opinion, but because of prior industry interest evolution at the domestic level. The US's early domestic regulation of aerosol CFCs began to shift interests at the domestic level – it reduced demand for CFCs in the US and put US industry in the position of wanted to even the international playing field, as existing unilateral phase-out disadvantaged them relative to Europe.[170] This fed back into policy positions, leading industry to tolerate or even support the US push for international regulation in a variety of ways. Meanwhile, the EC Member States, where industry had made more minor adjustments and enjoyed a competitive advantage as a result, were generally opposed to any regulation at the international level. The EC became a more aggressive supporter of regulation in various forms only in later rounds, after substantial shifts in industry interests led to shifts in national positions.

Plausible mechanisms by which industry interests might influence national governments and their negotiating bodies can be observed throughout the negotiation. I find multiple instances of active pathways for the transmission of industry interests to government actors and negotiators. Formal and informal lobbying behavior is present throughout, and changed over time. In some cases this lobbying is direct; in others it is organized through industry groups. For instance, in the pre-Montreal period the European Council of Chemical Manufacturers Federations lobbied the EC against regulation.[171] As noted above, Nigel Haigh attributes the UK's opposition during the pre-Montreal period to direct pressure from ICI.[172] Similarly, Jordan notes that British ozone policy in the decade before ozone negotiation was shaped by the "strong, trusting relationship" between ICI and the British government.[173] In the US, the industry group Alliance for Responsible CFC Policy (ARCP) began publicly supporting some level of controls on future CFC production in 1986, prior to Montreal.[174] Per Benedick, a last-minute possible pullout by the Reagan administration from the Vienna convention was averted in part by US industrialists who

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[168] Haigh, *EEC Environmental Policy and Britain*, 267.

[169] Ibid., 269.

[170] Benedick, *Ozone Diplomacy: New Directions in Safeguarding the Planet*.

[171] Ibid., 39.

[172] Haigh, *EEC Environmental Policy and Britain*, 269.

[173] Jordan, "The Ozone Endgame: The Implementation of the Montreal Protocol in the United Kingdom," 28.

[174] Alliance for Responsible CFC Policy, *The Montreal Protocol*.

backed international agreement around research.[175] In September 1986 the Alliance for Responsible CFC Policy, a US CFC producer and user industry consortium, came out in public support of international regulation of CFCs. Benedick says this "broke industry's transatlantic united front practically on the eve of international negotiations" and "created obvious tensions between American and European corporate executives who attended the diplomatic negotiating sessions in the following months."[176]

Following Montreal, and thereafter, evidence for pro-regulation or regulation-tolerant industry influence strengthened in the US and began to appear in Europe. For instance, in November of 1988, ICI requested international consideration for strengthening of CFC regulation.[177] The ARCP began supporting phaseout in September 1988.[178] In 1992, following industry evolution, the group called on the EPA to exceed the requirements of the London agreements, eliminating CFCs in 1996. Benedick credits this industry pressure in part for causing President Bush to reverse his previous position and authorize phase-out of CFCs, halons, carbon tetrachloride, and methyl chloroform in 1996, ahead of schedule.[179]

In those cases where it had adapted to regulation, industry also engaged in other kinds of interventions that improved the potential for stronger regulatory outcomes. As noted above, industry was reported to have communicated directly with executive government, in some cases (such as industry intervention with US President Reagan) preventing the executive from taking actions that would have been disruptive to treaty making. US industry also directly supported the advance of scientific knowledge that might have an effect on EC Member State positions: Benedick writes that it was the Chemical Manufacturers Association that "ultimately provided the British Antarctic Survey [which resulted in findings on polar ozone depletion] with the needed funds, because U.S. industry wanted an early resolution of the scientific uncertainties."[180] In 1990, US industry began holding an annual International Conference on Ozone Protection Technologies, sponsored by the Alliance for Responsible CFC Policy and focused on the replacement of ODSs.[181] In essence, at this point industry had become a cooperative participant in the solution-seeking side of the ozone epistemic community.

Contemporary observers assigned causal meaning to linkages between industry and negotiating position: In individual instances throughout, both Markus Jachtenfuchs[182] and Richard Benedick[183] report industry involvement as important to negotiating positions and to shifts in negotiating positions. Jachtenfuchs in particular noted the causal importance of shifts in industry interests to the aggregate EC position. He argues in his

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[175] Benedick, *Ozone Diplomacy: New Directions in Safeguarding the Planet*, 46–47.

[176] Ibid., 31–32.

[177] Ibid., 118.

[178] Ibid.

[179] Ibid., 197.

[180] Ibid., 30.

[181] Ibid., 200.

[182] Jachtenfuchs, "The European Community and the Protection of the Ozone Layer."

[183] Benedick, *Ozone Diplomacy: New Directions in Safeguarding the Planet*.

1990 analysis that "the willingness in principle of its industry to go ahead with CFC reductions more severe than those envisaged in the Montreal Protocol led… to the slow erosion of the UK position in the Council. … Only after ICI, the UK's biggest producer, had lifted its total opposition to further reductions did the British government soften its position within the Council, thus following the policy of ICI." And Jachtenfuchs notes the lack of similar change in France: "The French government for its part did not change its position as long as Atochem was not willing to reduce its production."[184] Similarly, comments such as Benedick's assertion that US industry support for Montreal was important and created consternation amongst European industry suggest not only that he attributed causal import to US industry influence, but that industry actors in Europe clearly did as well. If European industry did not expect shifts in US industry influence to matter, there would have been no cause for consternation.

Fine-grained correlations between national negotiating positions, national industry responses, and their results.

Shifts in individual countries' overall position on regulation matched well with the evolution of their individual domestic industries. This is in many cases true; in particular, we see a significant shift in British negotiating policy between the Montreal, London, and Copenhagen rounds that appears to be temporally sequenced with shifts in British industry: UK and EC positions in negotiation moderated and became increasingly pro-regulation in accord with shifts in British industry toward investment in CFC substitutes. Similarly, we see shifts in the US toward more aggressive domestic policy following initial consumer market shifts, as well as shifts toward more aggressive negotiating positions following aggressive investment of the US CFC industry in CFC substitute capacity. The contrast between the UK and other European countries is illustrative; countries whose industries invested more slowly, like France's Atochem – but also, for instance, Italy/Montefluos – shifted position on negotiations more slowly.

Industry investment choices among multiple substitute options also predict national negotiating positions among multiple regulatory options. Between London and Copenhagen, the leadership on faster phase-out of HCFCs shifted from the US to the EC, with the EC ultimately pushing the US faster than its industry interests were happy with. While the dynamic within the negotiations is not entirely clear, the correlation of national industry development with national and EC negotiating positions is suggestive. U.S. industry had two reasons to defend HCFCs in later rounds of negotiation. First, Benedick[185] attributes the reversal of positions on HCFCs to the fact that the US had a larger capital stock of legacy refrigeration and air-cooling equipment, for which HCFCs might be necessary in the short- and mid-term. In this sense, the US had run up against an industry interest that was difficult to shift quickly. Second, the leading US companies (Du Pont and Allied Signal) had invested actively in *both* HFCs and HCFCs, with Du Pont a leader in commercializing many, and Allied particularly active in partial substitute 141b.

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[184] Jachtenfuchs, "The European Community and the Protection of the Ozone Layer," 268.

[185] Benedick, *Ozone Diplomacy: New Directions in Safeguarding the Planet*, 205.

Meanwhile, of the major European producers, Germany phased out partial substitutes entirely by legal fiat, along with CFCs – Germany clearly had little or no remaining interests in HCFCs. Meanwhile ICI in the UK had focused heavily in zero-ODP substitutes like HFC-134a and chose not to pursue partial substitutes. This difference in priority meant that the UK, up to that point a bellwether for EC negotiating position, had an interest in preventing the undermining of HFC market growth by HCFCs,[186] as well as potentially in gaining advantage relative to its rivals abroad who had made different investment decisions. It is also the case that EC supporters of faster phase-out argued that suitable alternatives in appliances and equipment did exist from local producers – such as the propane/butane refrigerator developed by a German company (Rowlands 1993, 4).

Two of the three major players in Europe had already abandoned or been forced to abandon partial substitutes, while US industry was still pursuing them fairly aggressively. National negotiating positions – the US's, the UK's, Germany's, France's, and the EC's aggregated position – stayed consonant with these shifts.[187]

Absence of increasing policy viability accompanies absence of prior industry evolution.

New subjects of negotiation relevant to industries not previously affected and which do not have the benefit of prior rounds of policy-industry feedback start at "square one" in negotiations from a feedback standpoint. This dynamic is evident in the methyl bromide negotiations, a case in which a new substance was introduced late in the game (the Copenhagen round of negotiations) that was of primary importance to industries (agriculture) that had not previously been affected by earlier policy rounds. Several relevant players' industries were significantly implicated, including the US itself (a major producer and user) and France (which was a producer, along with Israel), as well as some other southern European states and many developing countries (users of methyl bromide).[188] These industry interests resisted reductions. They were largely successful in doing so; the only control passed on methyl bromide was a freeze at 1991 levels, to take effect in 1995.[189]

What is interesting about the methyl bromide negotiation is the extent to which it demonstrates the fate of a novel substance introduced to negotiations that is linked to industries that have not undergone prior evolution in interests. The users of methyl bromide were powerful agricultural industry interests, and they came to the negotiations fresh, with no prior trail of shifts in interest to adapt to regulation over time – in other words, no policy-industry feedback history. The result was precisely the kind of deadlock

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[186] Jordan, "The Ozone Endgame: The Implementation of the Montreal Protocol in the United Kingdom," 36.

[187] Benedick, *Ozone Diplomacy: New Directions in Safeguarding the Planet*, 291–292. As noted, France was the laggard on the EU side; in fact, an *Atochem* officer actually made statements offering tacit support directly to the US position in negotiations. (Chynoweth, "EC, U.S. Compromise Likely on HCFC Control.")

[188] Because a novel industry – agriculture – was implicated by the methyl bromide issue, the relevant players shifted somewhat to include countries that were methyl bromide producers and countries that were major users; opposition groups included not only France and Israel, but also countries like China, Indonesia, Kenya, South Africa, and others.

[189] Benedick, *Ozone Diplomacy: New Directions in Safeguarding the Planet*, 209.

seen on CFCs in earlier phases of negotiation. This was in spite of the fact that the effects of advancing scientific understanding and shifting public opinion about the importance of ozone preservation were presumably as relevant to methyl bromide as they were to CFCs, halons, carbon tetrachloride, and other chemicals already regulated. The southern EC Member States that produced and used methyl bromide were staunchly resistant to regulation. Even the US, which was seeking regulation of methyl bromide partly to even the playing field after previously-passed US legislation caught methyl bromide in its net, was undermined in negotiations by its own powerful, and anti-regulation, agricultural lobby.[190] The outcome on methyl bromide, therefore, strongly suggests that a prior history of policy-industry evolution is an important factor in determining the potential for successful regulatory negotiations; external factors such as the dissemination of scientific knowledge and opinion are not enough on their own.

CONCLUSION: THE GREEN SPIRAL IS CONVINCING AS AN EXPLANATION FOR THE SUCCESS OF OZONE NEGOTIATIONS

Policy-Industry Feedback vs. Alternate Explanations

I have argued throughout this chapter that the presence of a policy-industry feedback spiral convincingly explains the dynamics of the ozone negotiations at both the international and national levels. As discussed above, the green spiral fits the granular evidence seen in the case.

Moreover, the spiral model fits the overarching criteria for a strong theory, as discussed in Chapter 1: It explains the overall outcome of the negotiations. It explains the pace and character of the negotiations (momentum exists because negotiations become increasingly easy as configurations of industry interests were changing over time in ways that altered the structure of the issue area). It explains variation at the domestic level, with regard to individual nations' differing positions and differing rates of change (due to different rates of change in different nations' industries).

I want to conclude the chapter by arguing not just that this model explains the negotiations, but that it does so in many cases better than alternate proposed mechanisms, individually or in aggregate.

First, the policy-industry spiral mechanism accounts for national-level variation better than competing explanations do. Lines of theory built around epistemic community/knowledge dissemination or flexible treaty design, for instance, are less obviously capable of doing this. The generation of scientific knowledge and the existence of an expert consensus in the international community is not something that should obviously affect one country more than another. If the communication of knowledge about a problem is convincing to the U.K., why should it fail to convince France? We need some mechanism that explains different responses at the national level; the policy-industry feedback spiral does so. The same can be said about many treaty design-based explanations for treaty success: all the key players in this case faced the same treaty design, yet reacted in different ways. The flexible amendment and adjustment features of

[190] Ibid., 208.

the ozone convention explain why the convention was well-suited to capitalize on shifts in national-level positions over time; policy-industry feedback explains why those shifts happened in the first place.

Second, and similarly, the policy-industry spiral mechanism accounts more effectively for variation in response across issue areas within a negotiation. Again, mechanisms that rely on dissemination of knowledge about environmental problems don't provide an immediately obvious explanation for variation across subsets of an issue area. If the international community has reached a consensus that ozone depletion is a serious problem and that ozone-depleting substances must be controlled, this consensus should generalize to a novel ODS. The case of methyl bromide shows that it does not do so reliably; and the policy-industry feedback mechanism provides a convincing alternate explanation. Because methyl bromide was primarily relevant to a powerful industry, agriculture, that had experienced no prior policy-industry feedback process, policymakers found themselves back at "square one" on regulating it.

Scholars have responded to the difference in outcomes between ozone and climate change negotiations by pointing specifically at some factors that differ between the two cases. Some treaty design choices did differ between the two; for instance, the ozone agreements imposed trade restrictions on non-signatories. Separately, some have argued that the structural realities of the cases are different: climate change is a much harder problem than ozone. This deep dive into the ozone case does not speak as directly to these alternate theories. In my next two chapters, I will argue that an examination of the dynamics of climate change calls into doubt the efficacy of these explanations as well, and for similar reasons. As explanations, neither the omission of trade restrictions from climate change deals nor the structural realities of the climate change issue are consonant with the national- and regional-level variation in regulatory response that we see in climate change.

Two other points that emerge from this case also deserve some specific comment.

Epiphenomenality

While some scholars focus on explaining differences in environmental treaty making outcome, others have argued that these treaties are essentially epiphenomenal, merely encoding what interests such as industry are willing to do with or without a treaty. The presence of a policy-industry feedback mechanism also helps us understand this dynamic. Taken as isolated events, individual rounds of ozone negotiation often appear epiphenomenal. For instance, by the time the Copenhagen round of negotiations further tightened CFC phase-out schedules, industry was not resistant and many nations had already passed domestic legislation with comparable tightening.

This is observation is accurate as far as it goes: it is not usually difficult to explain why a round was successfully concluded given the configuration of interests at the point negotiations were held. The puzzle is in explaining why the configuration of interests allowing a particular outcome in a given round *changes between rounds* – as occurred in the ozone case. The policy-industry feedback mechanism suggests that although individual rounds of negotiation may in a sense be epiphenomenal at the point they occur, the process of treaty making – and feedback between policy and industry – is not.

The Role of Research and Development

Prior researchers have pointed out one aspect of the policy-industry feedback process quite consistently: the role of research and development in moving negotiations forward. It is widely claimed and accepted that one important feature of regulation (direct or via other strategies such as taxation or cap-and-trade) is that it provides incentives for the development of substitute products. A simple feedback process is postulated: Industry will strongly resist regulation when no viable alternatives exist, and will be seen as legitimate when it does so; once industry has created plausible substitutes, it will be possible to coax industry, albeit reluctantly, into transitioning to their use. Hence, feedback exists between policy and industry in the form of catalysis of technology development. This makes up part of the argument in the feedback process proposed by Melissa Durkee[191]. The catalysis of R&D is certainly an aspect of what occurs in the case of ozone – though as I have suggested, much of the early development of substitutes had actually already been accomplished in the 1970s and 1980s, such that companies were able to begin planning production facilities within months of the Montreal Protocol's creation.

As with many of the explanations posited in existing literature, the R&D mechanism has merit but does not go far enough by itself. In the following chapter on climate change, I will argue that R&D alone is not enough. A great deal of R&D has occurred around carbon-mitigation technology. A variety of lower-carbon substitute technologies exist across most industries. They are, granted, more expensive. But ODS substitutes like HFC-134a were also significantly more expensive when they first came into use. This suggests that the mere presence of substitutes is not enough. The question is whether a sufficiently large number of important industry actors have been coaxed into putting significant sunk costs into commercialization and production of substitute technologies. If so, industry will tend to back regulation that privileges substitutes and acts to create or grow markets for them. If not, industry will put substitutes on the back burner – just as it did prior to the Montreal Protocol – and resist regulation.

[191] Durkee, "Persuasion Treaties."

CHAPTER 4: CLIMATE CHANGE – THE CASE AT THE INTERNATIONAL LEVEL

INTRODUCTION AND BACKGROUND

Ozone and climate change make a useful contrast. Ozone is a case in which the green spiral is present, and negotiations are productive. Industry realignment is seen between rounds, and that realignment feeds back into political viability of regulation. Climate is a complementary case of failure. Over the following two chapters, I will look in detail at the climate case, first at the international level (Chapter 4) and then at the national/sub-national level (Chapter 5).

Examining the climate case allows me to accomplish several goals in two major areas of theory development. First, investigating a complementary case of negotiation failure lets me further illuminate the green spiral process itself. This case thus adds evidence for the importance of the green spiral in international negotiations. I will show that the green spiral process is not present at the international level in the climate case; this is further data consonant with the potential importance of the green spiral mechanism as a factor in success or failure of international environmental treaty making. In addition, investigating both an additional international case and a set of local cases allows me to investigate some of the factors that help or hinder the development of green spiral dynamics, suggesting when they can and cannot occur.

Second, contrasting climate and ozone negotiations allows me to shed further light on the general theory of environmental negotiations and the success factors that pertain to them. I will suggest that the contrast of the two cases shows several things: that existing explanations for success are unsatisfactory or incomplete; that subsequent explanations for the contrast between the two cases are also not entirely satisfactory; and that the addition of the green spiral mechanism provides an explanatory factor that can help us understand the success of the ozone negotiations *and* the pattern of international failure coupled with local successes that we see in climate.

The Ozone/Climate Contrast – Why It Matters Theoretically

The ozone and climate change negotiations are linked, and provide a productive comparison, for two reasons. First, they share practical similarities as issue areas. Both are serious, potentially existential threats that must be successfully dealt with in order to preserve the quality of human life as we know it. Both are technically complex, non-intuitive problems, in which we are forced to rely on incomplete and still-advancing science to help define the scope, pace, and likely impact of the problem; and in which direct effects on humanity are long-term rather than immediately tangible. Both are difficult, costly problems whose solution required major, costly changes within industries important to key players' economies. It has been argued that climate change is a much larger and more economically complex problem, affecting many more industries. This is true, and I address it below; however, neither problem was an economically trivial one to solve, and both cases began with significant industry resistance to change.

As a result, in each case, interested players began the negotiation process without existing political will to implement a full solution. In both, key players were willing to

negotiate, and the hope existed amongst pro-regulatory players that a multi-round process would allow for a successful ratcheting upward of reduction commitments over time, such that a full solution would eventually be found.

Second, the two cases share a theoretical framework and a design approach. Both are cases in which the basic problem is that of collective goods provision – solving the problem requires many players to cooperate in providing a solution that none is able to provide unilaterally. In both cases, a common-pool good must be preserved, even though preservation is costly to those who cooperate, and cooperators do not have the power to exclude non-cooperators from the benefits of their efforts. These problems are famously difficult to solve, because they offer significant incentives for players to attempt to free ride on the efforts of others. Hence, the successful solution of the ozone problem has generated a great deal of interest, as well as a fair amount of hope for the solution to subsequent comparable problems like climate change. Indeed, both scholars and contemporary officials at the time have regarded ozone treaty making as a direct model for climate change treaty making[192].

The approach taken to climate negotiations used a framework and design similar to ozone. Like ozone negotiations, climate negotiations were framed in a UN-administered convention-protocol framework. In this framework, on-going negotiations governed by an overarching convention (the United Nations Framework Convention on Climate Change) were expected to produce multiple interim agreements in the form of Protocols like the Kyoto Protocol, which might be modified by Amendments, and in which initial periods of regulatory control could be extended to subsequent periods. This process (it was hoped) would allow rounds of regulatory control to build on each other. The general paradigm for treaty outcomes – rounds of concrete reduction targets and timetables for developed countries with a separate, less demanding framework to move developing countries forward as well – was the same. Using the IPCC (Intergovernmental Panel on Climate Change), an expert body whose mission was to evaluate, synthesize, and communicate the current state-of-the-art in climate change knowledge, climate negotiators actively attempted to build an expert community and consensus like the one that had been perceived as useful in ozone negotiations. In a meaningful way, climate change negotiations attempted to operationalize what negotiators thought they had learned about successful international cooperation on serious environmental public goods problems. As such, the failure of climate negotiations is a useful lens for analyzing how well existing theory and best practices account for success and failure of this type of complex multi-round negotiation.

Brief Review of Prior Theory

It is useful here to briefly review some of the "lessons learned" from research on environmental negotiations, introduced in Chapter 1. I divide this review into two

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[192] Grundmann, "Transnational Policy Networks and the Role of Advocacy Scientists: From Ozone Layer Protection to Climate Change," 405; Oberthür and Ott, *The Kyoto Protocol: International Climate Policy for the 21st Century*, 282; Sebenius, "Designing Negotiations toward a New Regime: The Case of Global Warming," 113, 114–115; Thoms, "A Comparative Analysis of International Regimes on Ozone and Climate Change with Implications for Regime Design."

sections: factors that broadly do not differ between issue areas, and hence clearly do not offer a compelling explanation for outcome variation; and factors that do differ (at least to some degree). The latter section includes a discussion of why these explanations nonetheless do not seem to fully account for outcome variation.

Explaining Ozone Success: Factors that Do Not Differentiate Between Issue Areas

One major branch of literature emerging from analysis of the ozone negotiations focused on the development and mechanisms for spread of scientific understandings, and the role of such understandings in driving cooperation. Broadly, this branch of literature suggests that successful environmental negotiations are driven by the ability of experts to effectively come to consensus on the characterization of technical (e.g., environmental) problems and communicate that consensus to policy-makers. This was a key factor identified by Richard Benedick, lead US negotiator on ozone, identifies as a major success factors, and it is echoed in scholarly work by Peter Haas[193] and others. Similarly, the advance of technical knowledge around potential solutions is also an important factor in potentially increasing the feasibility of cooperation over time.

Second, as suggested above, treaty designers believed that there were features of treaty design that helped make ozone negotiations successful. Again, Benedick himself identified treaty design as a success factor.[194] The design of ozone negotiations was *flexible*, with an approach that allowed negotiators to agree to limited initial reductions, and then modify those targets (relatively) easily in subsequent negotiations. And, also importantly, it was *incremental*. The convention-protocol approach allowed parties to take appropriate steps in any given round without having to solve the entire problem or plan a full trajectory of cooperative action all at once; it also provided a "one-way ratchet" mechanism that consolidated gains that were made[195].

These features were synergistic with the mechanisms of developing scientific knowledge discussed above. It allowed negotiators to get an agreement hammered out without feeling they were locking themselves into a reduction trajectory that would be inflexible if evolving knowledge showed that the ozone problem was either more or less serious than it had at first appeared. Thus, the story goes, as scientific knowledge evolved and participants became more convinced of the seriousness of the problem, treaty design made relatively it easy to adjust commitments.

The climate convention/protocol design was broadly similar to the ozone treaty making design and attempted to capture many of the same virtues. There were some differences in approval mechanisms for changes and adjustments (see below) but the basic concept of a flexible, limited-commitment strategy that allowed parties to commit to reductions in the short term while allowing for long-term modification in response to evolving knowledge carried through. Because of the limited term of the initial Kyoto

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[193] Haas, "Obtaining International Environmental Protection through Epistemic Consensus"; Haas, "Banning Chlorofluorocarbons: Epistemic Community Efforts to Protect the Stratospheric Ozone."

[194] Benedick, *Ozone Diplomacy: New Directions in Safeguarding the Planet*.

[195] Sebenius, "Designing Negotiations toward a New Regime: The Case of Global Warming"; Thoms, "A Comparative Analysis of International Regimes on Ozone and Climate Change with Implications for Regime Design," 808.

commitment, parties did not need to fear being locked in to a permanent unjustified commitment.

These success factors drawn from the ozone story may be part of the story, but by themselves they do not appear to provide a complete, satisfactory account of environmental negotiation success. Success factors identified in ozone largely applied to climate. Knowledge advancement, epistemic consensus, and an incremental, flexible process were all present in the climate process, but did not result in success there. Why? Can we explain this cross-case variation using factors previously identified by the literature that do appear to differentiate between the two processes?

Explaining Climate Failure?: Factors that Do Differentiate between Issue Areas

As noted in Chapter 1, two major strands of explanation have been advanced for the failure of climate negotiations in contrast with the success of ozone.

First, some scholars have suggested treaty-design explanations. Although the climate negotiations follow a similar approach to ozone, there are differences. One particularly important omission is the lack of trade measures that punish non-participators. The ozone treaty included trade measures designed to impose costs on nations that did not sign on and participate in the ozone regime; the climate change negotiations have not. Another design explanation focuses on voting mechanisms, which were more demanding and hence potentially more obstructive in climate.

Second, structural conditions may provide an explanation. Perhaps climate negotiations are simply too hard. The magnitude of the problem is too large and the costs of a solution are too high; hence political will does not exist to pay for the solution. Similarly, the complexity of the problem is too great to grapple with – too many industries are implicated and represent potential opponents to regulation.

Close examination of the climate case leads me to find all of these explanations unsatisfactory. With regard to the first explanation, treaty design critiques, it is true that some measures were used in ozone and not used in climate and these lacks could theoretically lead to wariness from otherwise willing states. Trade measures were not incorporated in climate, meaning theoretically that the climate negotiations' institutional structure may have been less good at providing the kinds of club goods and punishments for defection that may help overcome the collective action problem. In addition, parties to ozone negotiations were willing to agree to less onerous voting procedures regarding amendments and changes than were parties to climate negotiations, which theoretically makes agreement and adjustment easier in ozone and more difficult in climate.[196] But

[196] Oberthür and Ott, *The Kyoto Protocol: International Climate Policy for the 21st Century*. Oberthür and Ott have stated that the voting mechanisms for modifying existing commitments were "not as progressive" as comparable treaties like ozone – proposals to allow for two-thirds majority decision-making, as found in the ozone regime, or circumvent lengthy ratification procedures for changes, failed to pass. This is factually accurate, but I am unconvinced that it is necessarily a very strong differentiator. Although the ozone design formally allowed for two-thirds majority decision-making, in fact parties did not really need to rely on this element to push decisions through. As Scott Barrett (Barrett, "On the Theory and Diplomacy of Environmental Treaty-Making"); as well as Robin Churchill and Geir Ulfstein (Churchill and Ulfstein, "Autonomous Institutional Arrangements in Multilateral Environmental Agreements: A Little-Noticed Phenomenon in International Law," 637) have noted, the Montreal Protocol operated by consensus in

these points simply beg the question, why not? Either such measures were not perceived as important by states (in which case their lack was not a critical factor in negotiation failure); or such measures *were* necessary for success, but the political will did not exist to create them. In that case, *why* did political will for a useful measure not exist? This chapter addresses that question.

With regard to the second explanation, it is of course unquestionably true that climate is a harder case than ozone, for the reasons discussed. And yet, there is a growing set of cases of successful carbon emissions regulation at the local level. Local cases of success suggest that there is nothing inherently inimical to regulation in the climate change area. So what allowed these local successes to occur and how does that factor relate to the international level? I address this question more fully in Chapter 5, which covers local cases of successful regulation; here I simply note the core point that such cases show that, at the least, the climate change issue area is not inherently inimical to regulation.

Both of these strands of explanation, in other words, beg the question of if and how the political will for carbon emission regulation *could* be created at the international level. Why was political will low at the start of negotiations, such that the scale of the problem exceeded the will to solve it? Why did political will not expand across rounds, although it did expand across rounds in the ozone case? And why does political will exist for unilateral regulation in local cases when it does not exist at the international level?

The Green Spiral, the Climate Case, and Environmental Negotiation

I suggest that the green spiral mechanism provides an explanation both for the lack of political will seen early in climate change negotiations, and the fact that, in contrast to ozone negotiations, political will has not developed over time. Chapter 2 explained how the presence of a policy-industry feedback process led to the development between rounds of increasing political will in the ozone case. I argue that the industry configurations seen at the beginning of the climate negotiations explain the baseline lack of political will. Subsequently, the lack of a global green spiral process in industry in the climate case explains why political will has not developed over time – even in the face of advances such as the increasing certainty and availability of scientific knowledge.

However, as I will discuss in Chapter 5, green spirals are not wholly non-existent in climate. They have occurred, at the local level, and they provide an explanation for the exceptional cases of success at the local level, in places like California and Denmark. These cases both provide additional scope for understanding the green spiral mechanism, and demonstrate that green spiral dynamics and successful regulation are not inherently impossible in the climate change issue area.

The green spiral as an explanatory factor thus has a specific set of virtues relevant to the climate issue area that are not captured by the existing literature. (1) It can help explain *both* the success of ozone negotiations and the failure of climate negotiations at the international level. (2) It accounts for the characteristics of climate negotiations that

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practice. This reinforces the general point above that the real lack here seems to be one of political will; institutional design here is an intervening variable that expresses political will (or lack thereof).

render existing explanations of failure unsatisfactory; as such, it offers a fresh and policy-relevant way of understanding the failure of climate negotiations. (3) As it did in ozone, the green spiral can help us explain not only international-level outcomes, but also the nuances of dynamics at the national and subnational level.

Plan of Attack

In the remainder of this Chapter, Chapter 4, I explore the case of climate change negotiations at the international level. In this chapter I demonstrate that, although there have been some marginal shifts that might eventually form the basis for a future green spiral, at the international level the negotiations to date have not been marked by the kind of policy-industry feedback dynamics and structural shifts in industry interests over time that characterize a green spiral. As a result of the lack of structural shifts in domestic industry interests, we also see a lack of the kind of momentum and increasing political viability of international regulation that is seen in the ozone case. Countries' negotiating positions do not change much, although to the extent that they change at the margins, they do so in ways that accord with the marginal shifts in domestic industry interests observed. The case is therefore consonant with the green spiral mechanism. This first chapter thus provides additional support for the green spiral mechanism, and suggests an explanation for the contrasting outcomes between the ozone and climate cases.

In the following Chapter, Chapter 5, I dig deeper, profiling four cases of local policy-making and industry evolution (or failures thereof): California, Denmark, Japan, and China. This second chapter builds on the ozone cases and the international climate case to provide a more complete picture of the green spiral mechanism: how it works across multiple cases; how it works in an economically complex case like climate; and subordinate factors that may make green spirals more or less likely to occur. Chapter 5 also makes the point that climate change is not inherently inimical to the green spiral mechanism or to regulatory success, by showing that green spirals can occur and can result in aggressive packages of emissions regulation even in the climate change context.

Overview of Climate Change and Climate Negotiations

Background – Scientific and Diplomatic History

The natural phenomenon underlying the climate change issue is the ability of carbon dioxide (CO_2) and other gases, collectively known as greenhouse gases (GHGs) to create a "greenhouse effect" in earth's atmosphere. The details of relevant geophysics are complex, but the fundamental effect is that as concentrations of GHGs in the atmosphere rise, larger amounts of solar radiation are trapped by the earth. A baseline greenhouse effect is inherent to the earth's atmosphere. But as the concentration of GHGs in the atmosphere climbs – e.g., through release of carbon from fossil fuels, or through methane-producing activities like agriculture and waste management [197] – the greenhouse effect becomes more intense, and the system moves toward higher average temperatures than current ecosystems are adapted for. Over time, this shift is expected to alter global

[197] EPA, "Overview of Greenhouse Gases."

weather, lead to major sea level rises, and produce various problematic secondary effects on existing ecosystems[198].

The scientific consensus around anthropogenic climate change emerged in the late 1970s and early 1980s. In the mid- to late 1980s, climate change as an issue emerged in the international diplomatic and policy structure. In 1985 a conference jointly sponsored by the United Nations Environment Programme, the World Meteorological Organization, and the International Council of Scientific Unions[199] endorsed the likelihood of warming[200]. In 1988, the Director of NASA's Institute for Space Studies testified before the US Congress that greenhouse-based warming was already occurring [201]. In 1988 the Intergovernmental Panel on Climate Change was established, to "provide the world with a clear scientific view on… climate change and its potential… impacts"[202]; that is, to create a public scientific consensus.

Formal climate change diplomacy began in 1992 with the establishment of the UN Framework Convention on Climate Change (UNFCCC). The diplomatic structure of climate negotiations was similar to that of ozone: the Convention did not in itself impose any regulatory requirements on parties. Instead, it established a forum for on-going multi-round negotiations. As with ozone, the Convention provided for future regulations to be negotiated as a series of Protocols. Meetings occur annually, but the analytically significant rounds are the 1997 Kyoto negotiations (which produced the Kyoto Protocol) and the 2009 Copenhagen round (which tried and failed to produce a follow-on agreement). This suggests the lack of momentum in climate change: a serious effort to intensify initial commitments took 12 years – and then largely failed.

Key Players

Key players in climate negotiations are determined by production of GHGs. A successful agreement must bring on board a sufficient percentage of total emissions to make a difference; hence it must satisfy some subset of the major emitters. A quick comparison of major emitters in 1990 (just before the 1992 Rio summit) and 2010 (just after Copenhagen) suggests key players over time (see Figures 1 and 2 below).

The reality of the negotiations reflect what these figures imply. Throughout, we can typically learn a great deal just from observing the biggest three: the US, EU, and China. Other major players are often circumstantially important.

At and prior to Kyoto, the EU, US, Japan, and Russia were critical players in the negotiations. Their choices at various points were turning points in the negotiations leading up to and during Kyoto's negotiation and ratification,[203] and often set the broad

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[198] *Climate Change 2007: Impacts, Adaptation and Vulnerability*.

[199] Now the International Council for Science.

[200] World Meteorological Organisation, *Report of the International Conference on the Assessment of the Role of Carbon Dioxide and of Other Greenhouse Gases in Climate Variations and Associated Impacts*.

[201] Shabecoff, "Global Warming Has Begun, Expert Tells Senate."

[202] Intergovernmental Panel on Climate Change, "Organization."

[203] Examples include US willingness to accept the Berlin Mandate in 1995 (Oberthür and Ott, *The Kyoto Protocol: International Climate Policy for the 21st Century*.), and Russia's choice to ratify the Kyoto Protocol,

Figure 1: Emissions by Country, 1990[204]

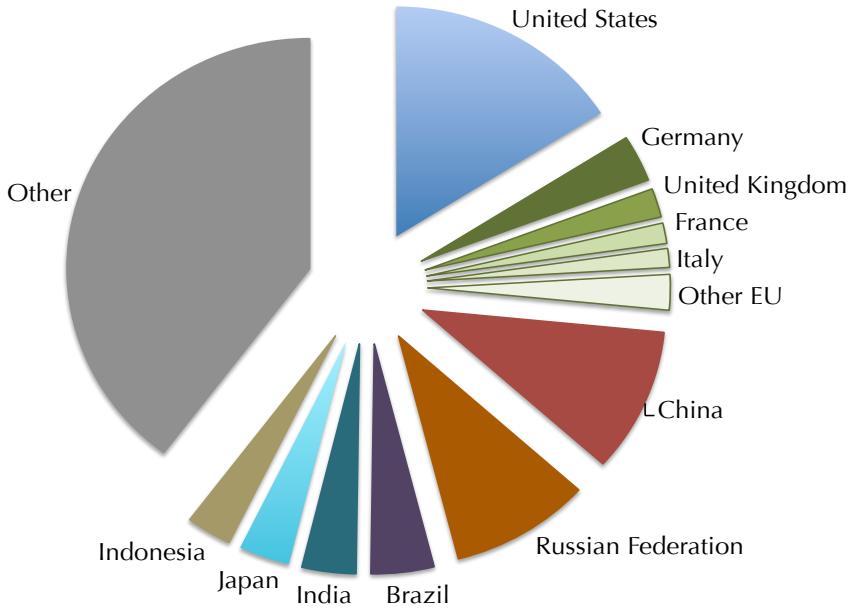
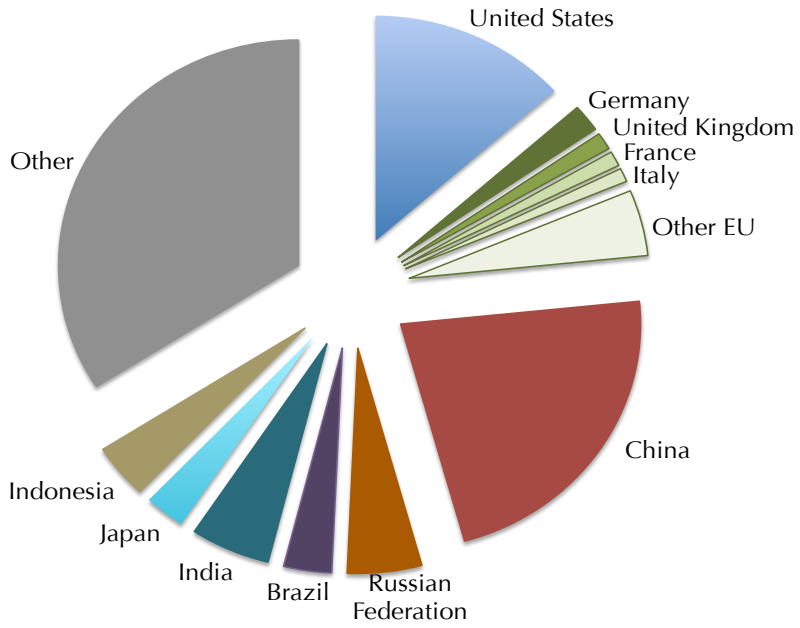


Figure 2: Emissions by Country, 2010[205]



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which was a key decision pushing the Protocol over the top to entry into force (Walsh, "Russian Vote Saves Kyoto Protocol"; "Russian MPs Ratify Kyoto Treaty.").

[204] EDGAR (Emission Database for Global Atmospheric Research), *GHG Time Series 1990-2010 per Capita Emissions for World Countries*.

[205] Ibid.

parameters within which negotiations could proceed. The triad of Japan, the US, and the EU dominated the final negotiations in Kyoto.[206] The biggest developing countries – China and India in particular – were important to the treaty's entry into force, but because developed players were willing to strike a deal that required no reduction commitments from developing countries but offered the prospect of assistance, their cooperation was relatively easy to obtain.

Over the course of the roughly 20 years of negotiations to date, this group has consolidated slightly. The US, EU, and China clearly remain key players, with China's practical importance coming to match its growing latent power as other players began pushing for it to take on concrete reduction commitments. These three largest players have a growing collective share of total emissions (driven by China's growth). At this point, any deal that attracted all three would be very strong; any deal that attracted even two would be fairly powerful. Russia and Japan have become less salient; India has become more so as its emissions grow and its future growth path looks steep, but still receives less attention than China.

The Kyoto Protocol

Negotiations

Kyoto produced the first round of concrete carbon emissions regulations, the Kyoto Protocol, which imposed very modest carbon reduction targets, only on developed-country signatories.

The EU took a leadership role in the Kyoto negotiations. The US and Japan were also both heavily involved in negotiations, including the most intense final negotiations. Both were somewhat hesitant but did negotiate reduction commitments in the signed Protocol text; Japan ultimately ratified, while the US did not. Russia, China, and India all refused to take on real absolute reduction commitments or accept a negotiation trajectory that promised future commitments.[207]

Outcome

The Protocol was adopted in December 1997 and entered into force February 2005.[208] To date 192 countries including the EU and its members as well as Japan, Russia, China, and India – but not the US – have ratified it.

Under the Protocol, developed countries (codified in Annex I) committed to binding targets for reducing GHG emissions between 2008 and 2012, using 1990 as an

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[206] Oberthür and Ott, *The Kyoto Protocol: International Climate Policy for the 21st Century*, 120.

[207] Russia's cap (at 100% of 1990 levels) was illusory, since the base year of 1990 predated a major drop in Russian emissions due to economic breakdown – Russia thus had a great deal of room to grow.

[208] United Nations Framework Convention on Climate Change, "Status of Ratification of the Kyoto Protocol."

index year[209]. The 2008-2012 commitment period was envisioned as the first of many. Parties were intended to meet repeatedly to extend and intensify their commitments as science developed and capabilities and commitment increased. National reduction targets in this first period varied from country to country and not all constituted absolute reductions (some were reductions relative to expected growth trajectory). Developed-country targets varied from -28% to +27%; Table 4 provides a short list of some key players' commitments.

Table 4: Major Emitters' 2008-2012 Reduction Commitments (v. 1990 Emissions)[210]

Country	Pledged Change Relative to 1990
United States	-- (Did not ratify)
European Union (Total)	-8%
France	0%
Germany	-21%
United Kingdom	-13%
Japan	-6%
Russian Federation	0%
China, India, Brazil	-- (Ratified, but not Annex I countries; no commitment)

As Table 4 makes clear, the reductions commitments made in the Kyoto Protocol's initial regulatory period were fairly weak, with modest commitments from the EU and Japan, non-participation from the US, and no commitments required from the developing countries.[211]

Copenhagen

Negotiations

The 2009 Copenhagen negotiations were seen as the last opportunity to design a second commitment period with stronger targets before the initial period of the Kyoto Protocol (2008-2012) expired. In this round, prospects for a deal largely depended on the collective willingness of the US, EU, and China to make concessions. The EU again acted

[209] A handful of Eastern European countries use a different base year.

[210] "Kyoto Protocol to the United Nations Framework Convention on Climate Change."

[211] How modest? The UNFCCC's 2011 review of the policies and measures (PaMs) being implemented by parties under the Protocol concluded that Annex I party emissions fell by 6% between 1990 and 2008, from 19 to 17.8 thousand Tg CO_2 equivalents. The UNFCCC estimated that total implemented and adopted PaMs would provide about 1.5 thousand Tg CO_2 eq savings by 2010, and 2.8 thousand Tg CO_2 eq savings by 2020. But there are two significant caveats. First, the 1990-2008 decline was only partly due to the PaMs themselves – major economic shocks also contributed[211]. Second, the same report projected that in spite of savings over baseline, Annex I emissions would rise back to 18.9 Tg CO_2 eq by 2020 (Subsidiary Body for Implementation, *Compilation and Synthesis of Fifth National Communications. Executive Summary. Note by the Secretariat.*). In other words, Kyoto made a difference – but not a big one.

as the leader and facilitator in the negotiations, hoping to negotiate a follow-on to Kyoto that would intensify reduction commitments for the existing signatories and bring in new players like the US. The US was cooperative but unambitious, offering a fairly weak commitment of 17% reductions versus 2005 [212]. China appeared to want a deal enough to be an active participant and negotiator, and was pursuing fairly aggressive carbon regulation at home. But it was ultimately unwilling to make concrete emissions reduction commitments in the international deal, which developed countries like the US and Japan demanded before being willing to agree themselves. India vacillated between uncompromising declarations and more conciliatory diplomacy.

Outcome

Copenhagen largely failed. The US remained uncommitted. China and India still refused binding commitments of any kind. Canada, Russia, and Japan declined second-period reduction commitments (Canada withdrew from the Protocol). In a strict sense, Copenhagen kept the process going; but it became essentially a regional effort, with the EU states alone among key players pledging a 20% collective reduction from 1990 levels.

The Copenhagen Accord

But there is an important caveat: the Copenhagen Accord, a set of non-binding emissions reduction pledges made by a broader group of nations than those willing to commit to binding reductions.

Table 5: Copenhagen Accord Pledges[213]

Country	Pledge Under Copenhagen Accord
United States	-17% emissions vs. 2005 by 2020; -42% by 2030; -83% by 2050
European Union (Total)	-20% to -30% emissions vs. 1990 by 2020
France	(see EU)
Germany	(see EU)
United Kingdom	(see EU)
Japan	-25% emissions vs. 1990 by 2020
Russian Federation	-15% to -25% emissions vs. 1990 by 2020
China	-40% to -45% carbon intensity vs. 2005 by 2020; will also increase share of non-fossil fuels and forest coverage
India	-20% to -25% carbon intensity vs. 2005 by 2020
Brazil	-36 to -39 vs. business as usual by 2020

Assessing the import of the Accord is hard. On the one hand, it is entirely non-binding, and does not commit countries to negotiate any subsequent cuts. Pledges are inconsistent

[212] Broder, "Obama Offers Targets to Cut Greenhouse Gas."

[213] NRDC, "From Copenhagen Accord to Climate Action: Tracking National Commitments to Curb Global Warming."

in type and baseline used. But the Accord does represent the first pledge by many nations (like China and India) of a concrete, quantifiable reduction target.

Broadly, this account of the climate negotiations suggests that there has not been a great deal of movement in the course of the climate negotiation. But the Copenhagen Accord *may* indicate some softening of position from some parties, especially China and India.

Industry Interests and the Climate Negotiations, 1997 - 2009

The goal of the core empirical analysis in this chapter is to suggest that the lack of progress between Kyoto and Copenhagen could plausibly result from the lack of a green spiral dynamic in the climate issue area. In the following section, I want to show two things empirically to support this proposition. The first is that, in climate as in ozone, national negotiating positions correlate to aggregate national industry interests. This is a prerequisite for industry reconfiguration to be relevant to negotiation dynamics. The second is that this case is not characterized by the type of structural shifts toward regulation-adapted industry interests that we see in ozone. These two empirical findings do not *prove* that negotiations did not succeed because there was no green spiral; that counterfactual would be very hard to demonstrate conclusively. But these findings are consonant with the importance of the proposed mechanism, across a complementary case.

I will make the first empirical point by performing two single-round analyses of the configuration of industry interests in key players at two points: around the 1997 and 2009 negotiations. An analysis of industry trends between the two rounds speaks to the second empirical point.

For clarity in the second empirical point, it is useful to first discuss the counterfactual: what would a green spiral look like in climate? A wide variety of economic activity is linked to GHG emissions, but broadly, energy generation (including motor fuel combustion) and industrial processes make up a large majority of the US, China, and Europe's emissions.[214] Within these sectors, several specific industries are highly impacted; relatively large and cohesive; and have active interests in this area. These include fossil fuels production industries (especially oil, motor fuel, and coal), which are highly negatively impacted by GHG emissions regulation; green industry (such as solar and wind), which strongly benefits from regulation; and the electricity generation and motor vehicle transportation industries, both of which can adapt to regulation but face up-front costs in terms of investment and business restructuring. GHG emissions regulation also generally impacts manufacturing industries as a whole, but the specifics vary widely by type of product – some are clear losers; others may be able to shift production to low-emissions products or capture net-positive outcomes from efficiency improvements. Therefore, I focus on indicators for the four industries noted above – fossil fuels, energy

[214] 87-91%, based on UNFCCC reports of GHG emissions by sector. Precise comparison is difficult as the latest data available for China is relatively old (2005) (United Nations Climate Change Secretariat, *GHG Emission Profile - United States of America*; United Nations Climate Change Secretariat, *GHG Emission Profile - European Union (27)*; United Nations Climate Change Secretariat, *GHG Emissions Profile - China*).

generation, green industry, and transportation – in both my single-round and industry trends analyses.

A productive green spiral process requires that industry interests shift sufficiently following initial treaty outcomes to change the structure of aggregate industry interests. In this case that means we will be looking at the period between the 1997 Kyoto Protocol and the next major regulatory effort in 2009. If a green spiral were present we would expect to see some or all of the following (1) shrinkage in opposing interests (fossil fuels); (2) growth in pro-regulation interests (green energy); and (3) adaptation of industries that can adapt to regulation (electricity generation and transportation). In practice we would be looking to observe *reductions in the share of fossil fuels energy generation* (which speaks to (1) and (3)); *growth in the share of renewable energy generation* (which speaks to (2) and (3)); *growth in the absolute size of green industry* (which speaks to (2)); and *reductions in the per capita use of motor fuel* (which speaks to (1) and (3)).

Single-Round Analyses: Industry Interests in Key Negotiating Rounds

To examine national industry configurations across the fossil fuels and renewable energy industries, I have constructed two indices, to summarize key players' level of activity in each area. Both indices rate countries on a simple five point-scale, based on five characteristics, in and around 1997 and in and around 2009. Since both the absolute size and relative sizes of relevant industries can be important, the indices include both absolute and relative measures. The characteristics chosen are not an exhaustive portrait of relevant industry. However, in aggregate they provide a rough, but solid general evaluation of the balance between fossil fuels and renewable industries for key players given the limitations of available comparative data. These characteristics are as follows:

Fossil Fuels Industry:

1) Absolute size of oil production[215] (is country's percent of world oil production greater than 1 standard deviation from zero?[216])

[215] For this oil production, I use a data set that excludes a small set of Middle East super-producers to make this calculation, since my interest is not in specialized super-producers but in the importance of fossil fuels as a sector within the key players, relative to global norms. Including the Middle East super-producers distorts the analysis of global norms.

[216] The classic formula for standard deviation uses the mean of the data set to calculate this value. This calculation makes sense if we believe variation in the data to be distributed roughly symmetrically around the mean; or if we do not know the distribution of the data, but are willing to assume a roughly symmetrical distribution around the mean. In this case, we know something about our data, however: because a country cannot produce less than zero of a resource, all values are positive; and because significant oil production does not occur in many countries, the distribution peaks at roughly zero with a long tail of positive values. Therefore, for this and calculations below that deal with similarly distributed data (peaking at or near zero), I have used zero rather than the mean to calculate variance. Thus, this measure measures standard deviation from zero rather than standard deviation from the mean. Note that I use the same formula for per capita motor gasoline use; although this curve does not peak precisely at zero, it is close enough that the results for categorization of key players are in all cases identical whether using zero or a small offset to the peak of the curve.

2) Importance of institutionalized oil industry (does country host at least one top-25 oil major?)
3) Reliance on fossil fuel-based transportation (is country's per capita use of motor gasoline greater than 1 standard deviation from zero?)
4) Absolute size of coal production (is country's percent of world coal production greater than 1 standard deviation from zero?)
5) Importance of coal industry to national economy (is country's per capita coal production greater than 1 standard deviation from zero?)

Although natural gas is an important fossil fuel, its regulatory interests and impact on national negotiating positions is ambiguous,[217] and I have therefore not included it in this index.

Renewable Energy Industry:

1) Absolute size of renewable energy power generation (is country's percent of world renewable power generation greater than 1 standard deviation from zero?)
2) Relative importance of renewable generation to economy (is per capita renewable generation greater than 1 standard deviation from zero?)
3) Green manufacturing – solar (is country a significant center of solar energy equipment manufacturing?[218])
4) Green manufacturing – wind (is country a significant center of wind energy equipment manufacturing?[219])
5) Green energy manufacturing – biofuels (is country's production of fuel ethanol greater than 1 standard deviation above zero?)

Nuclear is also a carbon-free source of energy. I have not included it in this index because, like natural gas in fossil fuels, nuclear energy's place in green energy is ambiguous at best.[220]

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[217] Because combustion of natural gas generates significantly less CO_2 than oil or coal, natural gas can be viewed as a stepping-stone to a lower-carbon economy. In this context, natural gas producers could see advantages to carbon regulation even though natural gas use does produce carbon emissions. However, natural gas is often but not always co-produced by oil producers. It is likely that natural gas producers that *also* have significant oil businesses will behave like oil producers, but natural gas specialists may (or may not) be more oriented toward carbon regulation.

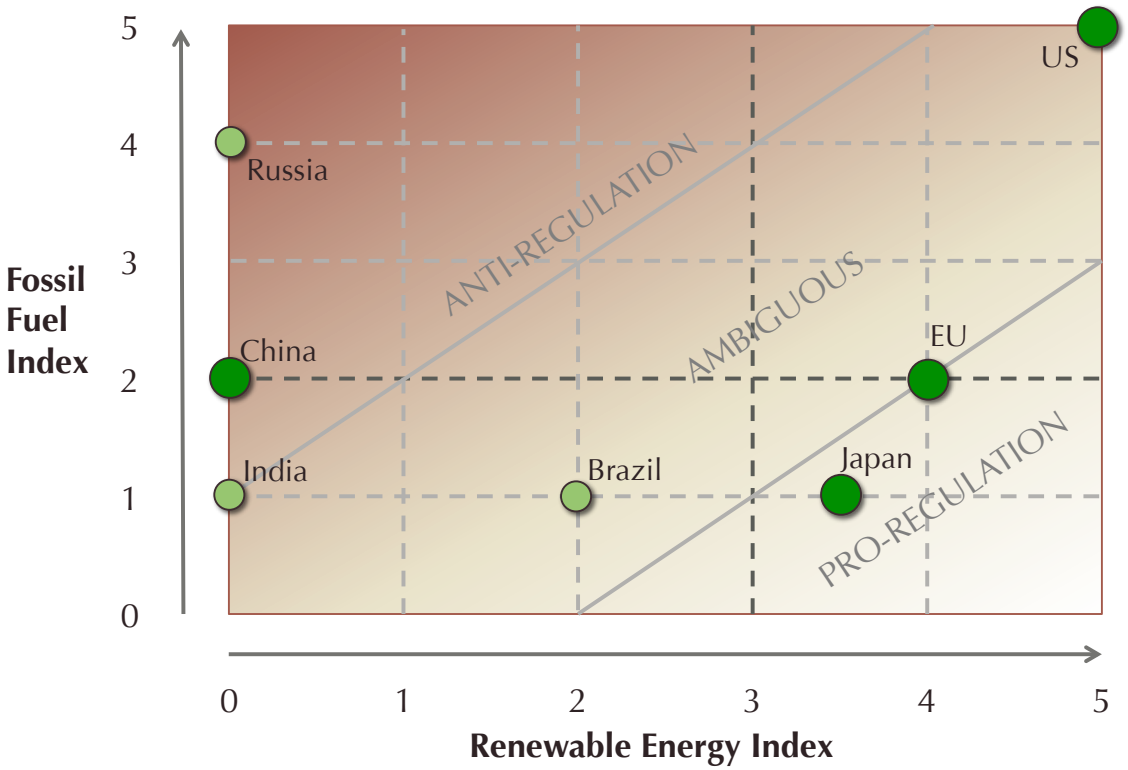
[218] This was determined by examination of percent of global market attributed to each player; examination of specific company activity where necessary; and whether or not country hosted one or more "top 10" solar producers (Earth Policy Institute, *Annual Solar Photovoltaics Production by Country, 1995-2012*; Fraunhofer Institute, *Fraunhofer Institute for Solar Energy Systems ISE: Photovoltaics Report*.).

[219] Determined by examination of location of wind turbine manufacturers and parts manufacturers culled from several "comprehensive" lists of manufacturers maintained by various wind industry sources, and whether or not country hosted one or more "top 10" wind turbine manufacturers (Cleantech Investor, "Wind Energy Companies A-H"; The Wind Power, "Wind Turbine Manufacturers.").

[220] Europe does not include nuclear energy in renewable fuels targets, so it does not benefit from regulation. The US does not formally exclude nuclear, but in general, nuclear is not supported by political factions that support green energy and is less likely to benefit from green energy packages. An effort to include reactor funding in the 2009 US stimulus package's large green industry funding package was in fact cut from the bill (Philips, "The U.S. Nuclear Power Industry's Dim Future"; "'Nuclear Pork' Cut out of Final Recovery and Reinvestment Package."). It is possible that nuclear could benefit from *local* emissions reductions efforts in

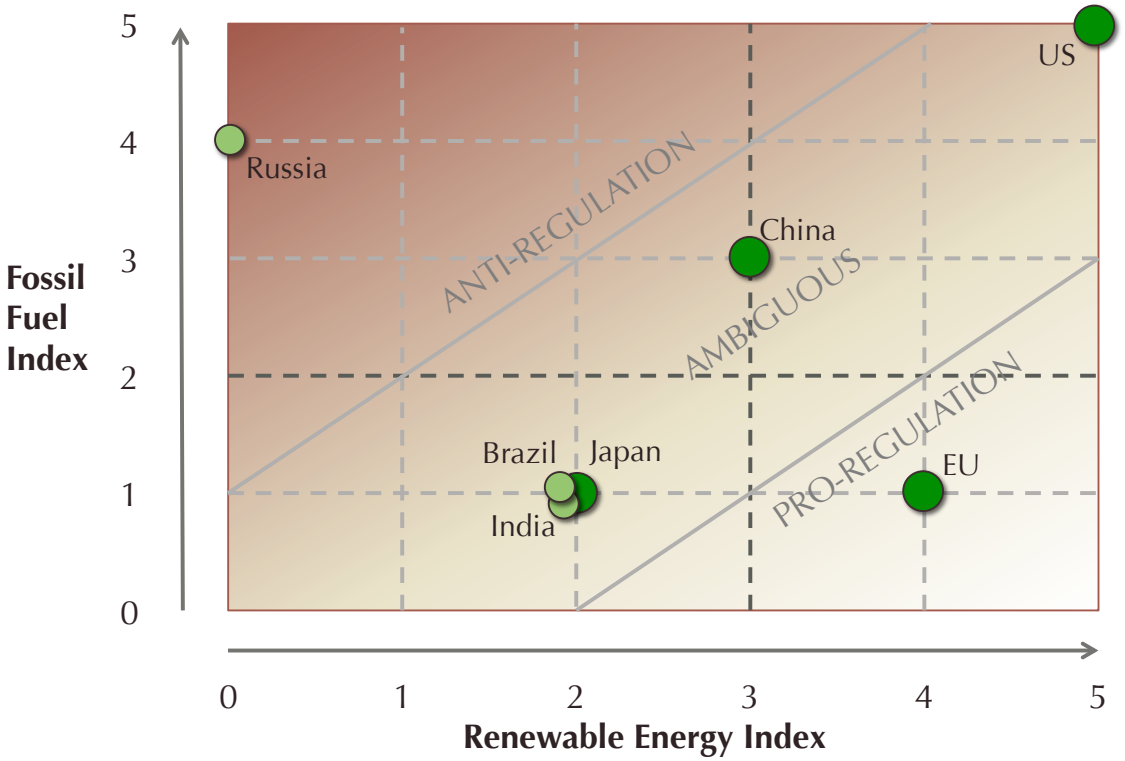
Figures 3 and 4 visualize the combination of the indices described above, as two-by-two matrices. The upper left and lower right quadrant are extremes. On the upper left, countries with major fossil fuels industries and little renewable energy industry will strongly resist carbon regulation. On the lower right, countries that are strong in renewables and weak in fossil fuels are likely to be in favor of carbon regulation. The middle of this chart, running from the lower left to the upper right quadrant is ambiguous, but in two different ways. In the lower left, countries weak in both domestic fossil fuels and renewables will likely be apathetic, neither fighting for nor crusading against regulation. On the upper right, countries strong in both industries are likely to be fairly engaged but take conflicting or mixed positions, reflecting conflict within their economies.

Figure 3: Industry Configurations in Key Players, 1997



other countries (South Korea or China). But given that several major players in international negotiations do not favor nuclear, it is unclear that the nuclear industry has any stake in *international* carbon emissions regulation.

Figure 4: Industry Configurations in Key Players, 2009



Of course, these positions sit within the context of the basic fossil fuel dependence of the global economy. Fossil fuel consumption is a fundamental basis for economic activity in most countries; thus, even without local fossil fuel production, interests tend to skew against regulation. Only countries quite close to the lower right are likely to be *strongly* pro-regulation. I have roughly subdivided the chart into a spectrum of three areas that reflect this skew: a relatively small "pro-regulation" area, a sizeable "ambiguous" middle, and an anti-regulation area that is significantly larger than the "pro-regulation" area. Again, these demarcations are intended to be illustrative rather than precise.

There are two key takeaways from this analysis. First, national interests match national negotiating positions quite well. The EU is the only player that stays firmly in the bottom right quadrant in both periods. It is also the only player that seemed strongly pro-regulation in both periods,[221] willing to offer side payments in some cases.

China shifts from the far left to the middle (the area I have labeled "ambiguous"), with strong growth in green indicators, but some growth in brown indicators as well. This matches China's positions: no commitments in 1997 and a conflicted stance in 2009. China vacillated to some degree publicly; it took a firm public line in the 2009

[221] Oberthür and Ott, *The Kyoto Protocol: International Climate Policy for the 21st Century*.

negotiations, refusing to accept binding reductions or caps.[222] But it was working furiously to reduce emissions intensity at home,[223] and talking reassuringly about these efforts and future goals,[224] sometimes hinting at the possibility of more compromise.[225] This contrast was confusing to negotiators, particularly Europe. Some officials concluded that China's strong internal efforts might mean that it was ready to be a cooperative player and support treaty making efforts, and that hardline stances were simply opening negotiating bids.[226] But with growth in both green and brown industry, China's equivocal stance quite simply matched its ambiguous position. China planned to continue and expand internal regulation, and wanted to grow green export markets, but could not commit to hard limits on its growth.

The US, which has significant strength in both fossil fuels and renewables in both periods, appeared conflicted or ambiguous in both rounds. It was heavily involved in negotiations in 1997 but failed to ratify (Cass Sunstein refers to the US's position in 1997 as "equivocal"[227]). In 2009 the US was not willing to make the kind of major concessions for a deal that the EU was, such as agreeing to reduction commitments without matching commitments from China and India;[228] it refused to rejoin the Kyoto process unless China and India did as well. But it did ultimately offer a weak voluntary pledge under the Copenhagen Accord of 17% reductions from 2005 levels.[229] The EU officials vacillated between considering the US or China the greater obstacle to a deal.[230]

Other players' positions similarly tended to match their industry interests as displayed here.[231] Japan was the other key player (along with the EU) that ratified the Kyoto Protocol, but it refused to commit to an extended reduction target in 2009. Finally, India took a position somewhat similar to China's, but somewhat less cooperative. India's early stances, like China's, were hardline stances,[232] especially on technology transfer.[233] It

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[222] Anderlini and Harvey, "China Gets Tough on Climate Talks"; Broder and Ansfield, "China and U.S. in Cold War-like Negotiations for a Greenhouse Gas Truce"; Lamont and Harvey, "China and India to Resist Caps on Carbon."

[223] Harvey, "China to Lead on Climate Change"; Dyer and Harvey, "A High-Wire Act."

[224] Dyer, "Beijing on Big Charm Offensive."

[225] Hille and Harvey, "Beijing Hints at Softer Line on Emission Cuts in Climate Talks."

[226] Anderlini and Harvey, "China Wants Rich Countries to Cut Greenhouse Gas Emissions by 40%"; Chaffin, Harvey, and Morris, "EU Sees US as Biggest Obstacle to Agreement."

[227] Sunstein, "Of Montreal and Kyoto: A Tale of Two Protocols."

[228] "'As Night from Day'"; MacFarquhar, "You First, Nations Say, as 100 Leaders Prepare to Meet on Climate Change."

[229] Broder, "Obama Offers Targets to Cut Greenhouse Gas."

[230] Broder, "The Climate Bog"; Chaffin, Harvey, and Morris, "EU Sees US as Biggest Obstacle to Agreement."

[231] Russia is an apparent anomaly, as it did ratify the Protocol and did accept a theoretical binding emissions cap. But this is deceptive. During Kyoto, Russia was generally resistant to regulation [231]. But the particular terms of the Kyoto Protocol, including the choice of 1990 for a base year, required no real reductions from Russia and advantaged it in carbon emissions trading.[231] Moreover, for signing on to Kyoto, Russia also received the EU's support on Russia's accession to the WTO [231].

[232] Lamont, Chaffin, and Harvey, "India Widens Climate Rift with West."

seemed to waver at times,[234] and may have been divided internally,[235] but was ultimately unwilling to make significant binding promises.

Second, overall, several key players moved from the left of the chart into the "ambiguous" middle, but none transitioned into the lower right quadrant where we would expect strong supporters for regulation. Meanwhile, Japan fell off somewhat. We might expect some softening of anti-regulation stances, but not much growth in the pro-regulation coalition per se. This matches well with the overall negotiation outcomes: a weak agreement in 1997, driven by the EU and Japan; and no strengthening in 2009, but willingness from some players to make new non-binding promises.

In short, taken as snapshots, we see a strong correlation between domestic industry interests and national negotiating positions in both 1997 and 2009. Domestic industry configurations did not provide enough support for a strong pro-regulatory coalition in 1997, and that had not changed by 2009. At best, we can argue that some key players – most notably China – have moved from "opposed" to "ambiguous." But this has not been enough to open up political viability for a stronger deal; the coalition of active supporters has not grown. Therefore 1997 resulted in a very weak agreement, and players were unable to strengthen that agreement in 2009.

This is very much a "birds-eye" level analysis that looks at industry configurations in a relatively abstract way. It is worth noting, therefore, that work that looks more closely at the political processes of this time also supports the conclusion that there are clear connections between industry interests and influence and treaty making outcomes. For instance, Jonas Meckling[236] traces in great detail the interaction between transnational industry coalitions and policymakers in the climate negotiation process leading up to Kyoto. His findings support the conclusion that industry influence was an important factor in determining the negotiating positions taken, instruments chosen, and ultimate outcomes of the Kyoto negotiations. Moreover, the sources and impacts of industry influence he observes broadly align with the analysis above. Growing green (or green-tolerant) interests in Europe and the mix of green and brown interest in the US were critical, as a transnational coalition of green-tolerant business provided key support in introducing and defending the market-based instruments ultimately incorporated in the Kyoto Protocol, while strong opposition from a coalition of interests headed by US fossil fuels industry helped to limit what could be accomplished (among other things, preventing the US from ratifying Kyoto). In other words, the EU's relatively strong green interests in combination with the US's mixed bag helped determine what Kyoto could become.

Analysis of the differences (and lack thereof) between the Kyoto and Copenhagen rounds leads into my second empirical point – the lack of structural reconfiguration between rounds. In the next section, I take a deeper dive into the industry trends between rounds of negotiation to examine whether they match expectations.

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[233] Lamont and Harvey, "Singh Calls for Sharing of Clean Power"; Williams, "Move to Avert Patents Clash at Climate Change Meeting."

[234] Harvey, "China to Lead on Climate Change"; Hille and Kazmin, "Asia Hits Back on Climate Change."

[235] Dyer and Harvey, "A High-Wire Act."

[236] Meckling, *Carbon Coalitions: Business, Climate Politics, and the Rise of Emissions Trading*.

Dynamic Analysis of Industry Trends, 1997 - 2009

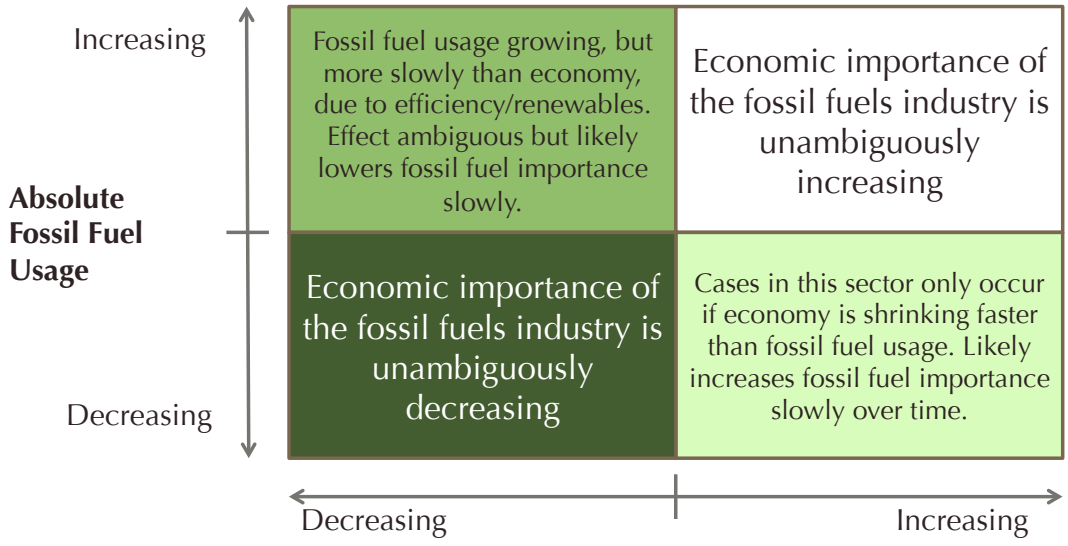
A closer examination of relevant industry dynamics over time between 1997 and 2009 accords with the single-round analyses above. There is little evidence of structural industry reconfiguration between Kyoto and Copenhagen. There are some important changes, most notably the significant growth in the absolute size of green industry. But the impacts of these changes are marginal rather than structural, as I will discuss below.

To assess whether a reconfiguration of industry interests occurred between Kyoto and Copenhagen, we must examine the trends in the balance of power between brown and green industry, asking to what extent each is growing or shrinking. This analysis centers on trends in fossil fuel-based power generation versus trends in renewable power generation. Energy generation data provides a fairly good proxy for the general trends in industry interest importance in key players, since it is linked to at least three (fossil fuels production, electricity generation, and green industry) of the four major industry groups discussed above. However, I have supplemented the generation data with a high level qualitative look at changes in transportation and renewables manufacturing (as distinct from generation).

Dynamics in Fossil Fuel Interests

Both absolute and relative growth are relevant to this issue.

Figure 5: Conceptual Matrix of Fossil Fuel Trends



The absolute size of the fossil fuels industry is a measure of absolute economic power, the actual resource base and constituency. In contrast, fossil fuels energy intensity (fossil fuels usage per unit GDP) is a measure of relative economic power. How important is fossil fuels generation to the economy, as a share of consumption or inputs to production? Any

combination of trends between the two can be observed: rising size and rising intensity; rising size and declining intensity; and so on. Figure 5 above provides a visual summary of the possibilities.

The two quadrants on the left are most relevant to the green spiral; countries in either of the right quadrants clearly do not have shrinking fossil fuel interests. The lower left quadrant is the ideal: if fossil fuels' absolute usage and energy intensity are both decreasing, then the fossil fuels industry is unambiguously shrinking in importance.

The quadrant on the upper left is ambiguous. Here, absolute fossil fuels usage is growing, but energy intensity is declining, so its rate of growth must be slower than that of the economy. This results from some combination of substitution (renewables for fossil fuels) or efficiency. In practice, decreasing energy intensity is typical of most economies over time, and has not historically led to a structural decrease in the power of fossil fuels.

In short, we can confidently conclude that fossil fuels interests are shrinking for countries in the lower left quadrant, but countries in the upper left quadrant are likely to experience marginal changes in interests at most. Figure 6 shows trends in absolute fossil fuels generation and fossil fuels energy intensity for key players as a two-by-two matrix. Figures 7 and 8 provide detail on the two measures. Europe is represented by the three major powers: the UK, Germany, and France.

Figure 6: Fossil Fuel Energy Generation Trends (2010 as Proportion of 1995 Levels)

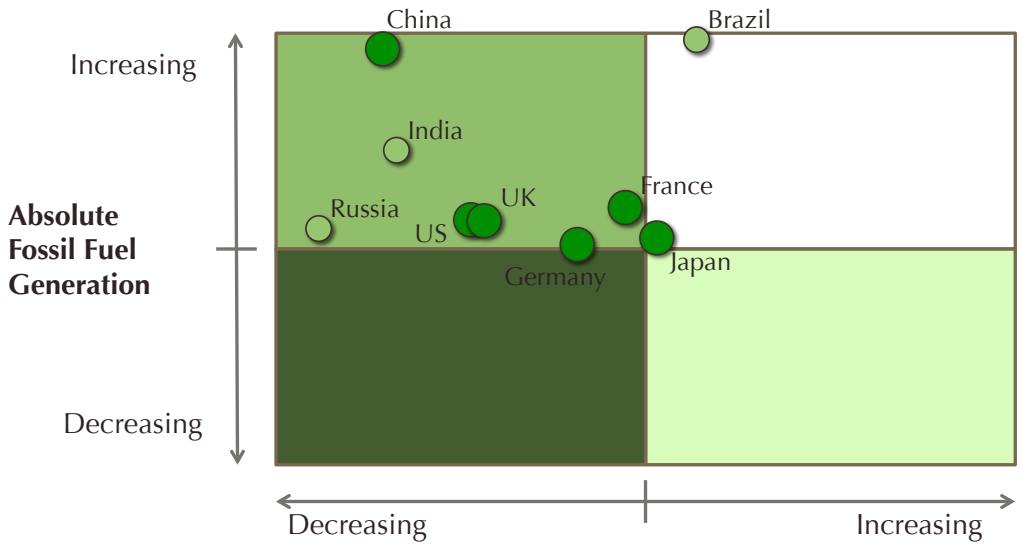


Figure 7: Total Fossil Fuel Electricity Generation, 1995-2010 [237]

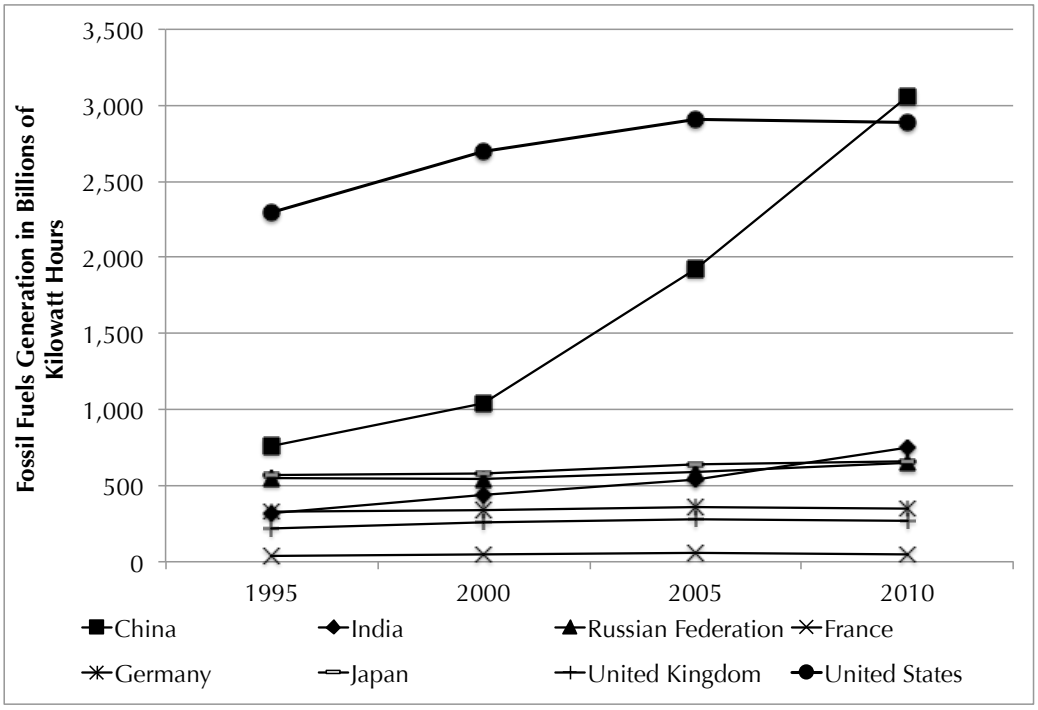
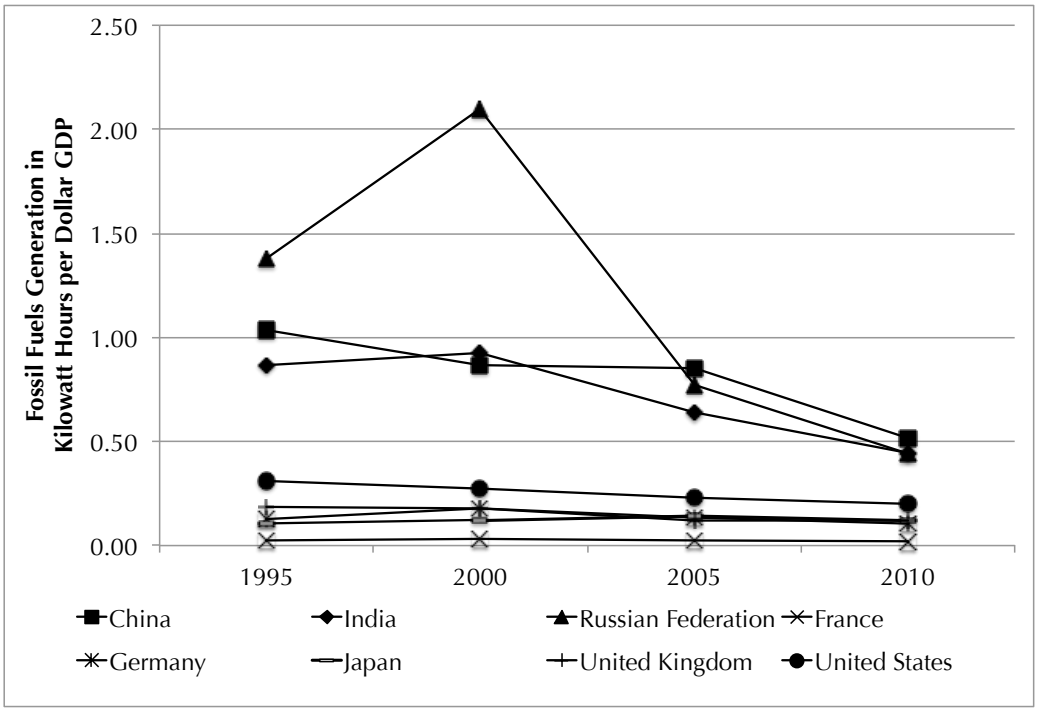


Figure 8: Fossil Fuel Electricity Generation per Unit GDP, 1995-2010 [238]



[237] USEIA, "Total Fossil Fuels Electricity Net Generation."

[238] Ibid.; World Bank, "GDP (current US$)."

The bottom line is that there are no players in the bottom left quadrant, players for whom absolute fossil fuel usage is declining significantly. There are some players where per-unit-GDP usage is declining meaningfully (China, India, Russia) but these economies are precisely those that are showing significant absolute growth (China, India) or are fundamentally predicated on fossil fuels production (Russia).

Getting into the lower quadrant may appear somewhat unlikely because it would require a major deviation from business as usual – but that is precisely the point. Fossil fuel industries enter this period large and powerful; a shift in aggregate interests from this sector requires a significant change from prior trends. Marginal decreases in energy intensity without absolute usage decreases do not accomplish this. Fossil fuel interests are likely to shrink substantially only if countries begin adding renewable energy generation or converting existing generation fast enough to cause an absolute drop in fossil fuel usage.

This data simply does not suggest structural changes to domestic fossil fuel interests, though there may be some minor evolution at the margins for the developed countries. These fossil fuel power usage trends conform to historical precedent rather than deviating from it. Developing countries' rapid growth typically leads to significant absolute usage increases even while they make major gains in efficiency. Developed countries tend to capture moderate efficiency gains steadily but more slowly. To date, addition of and conversion to renewable energy generation has not occurred fast enough to lead to absolute decreases in fossil fuels generation in the face of these constraints; renewables are not yet growing fast enough to support structural reconfiguration (see below for further discussion from the perspective of green industry trends).

Dynamics in Transportation

Table 6: Trends in Motor Fuel Usage Per Capita[239]

COUNTRY	Percent Change 1997 - 2009	Began to Decline In	Percent Decline from Peak
Brazil	7.7%	N/A	N/A
China	240.5%	N/A	N/A
France	**-7.1%**	**2002**	**-13.0%**
Germany	**-13.0%**	**2000**	**-17.2%**
India	43.9%	N/A	N/A
Japan	**-11.6%**	**2003**	**-12.3%**
Russian Federation	74.0%	N/A	N/A
United States	**-3.5%**	**2006**	**-12.5%**
United Kingdom	**-6.8%**	**2004**	**-9.8%**

[239] World Bank, "Road Sector Gasoline Fuel Consumption per Capita (kg of Oil Equivalent)"; World Bank, "Road Sector Diesel Fuel Consumption per Capita (kg of Oil Equivalent)."

Transportation trends can be divided between developed and developing countries. In both groups, per capita usage was climbing until the early to mid-2000s. Then, trends diverged. In developing countries, usage continued to climb, often quite rapidly. But between 2000 and 2007, most of the key developing countries' per capita usage of motor fuels (gasoline and diesel) peaked and began to drop. These trends are summarized in Table 6, below.

Some of these countries have captured substantial declines since peak use, but with the exception of Germany and Japan, by 2009 none have reached double digits of decline relative to 1997. The fact that countries that had been growing began declining during this period is a break from historical trends. It is plausible that policy-making in the Kyoto regulatory period is at least in part responsible (although it is difficult to separate such an effect from the baseline effects of rising fuel prices and economic crises). Since usage trends peaked several years after Kyoto, in terms of altering interests between the 1997 and 2009 negotiation rounds, the decreases are mostly not large. It is possible that if these trends continue, however, they may make a difference in the future. If the proportion of low- or no-carbon vehicles rises over time and the importance of motor fuel in consumer and business budgets declines, this will over time build regulation-adapted constituencies in the transportation industry and decrease incentives to resist regulation. Of course, consumption is still growing strongly in the industrialized key players.

Dynamics in Green Industry Interests – Generation and Manufacturing

Finally, to understand the dynamics of renewable energy industry between Kyoto and Copenhagen, we can use the same lenses we used for the fossil fuels energy industry – trends in the absolute size and relative importance. Here, an increase in one or both could correlate with an increase in political will for regulation.

Figure 9: Renewable Energy Generation Trends (2010 as Proportion of 1995 Levels)

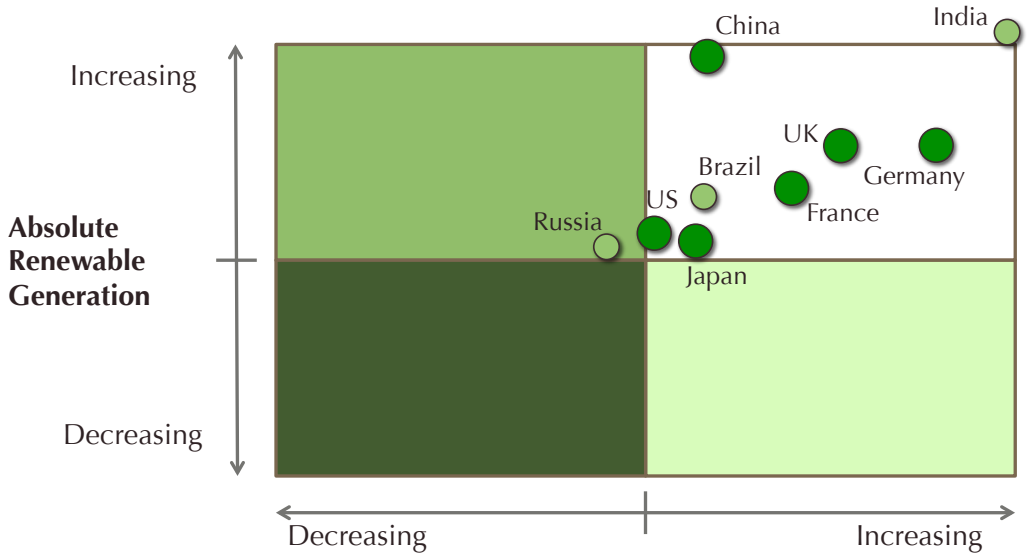


Figure 10: Total Renewable Electricity Generation, 1995-2010[240]

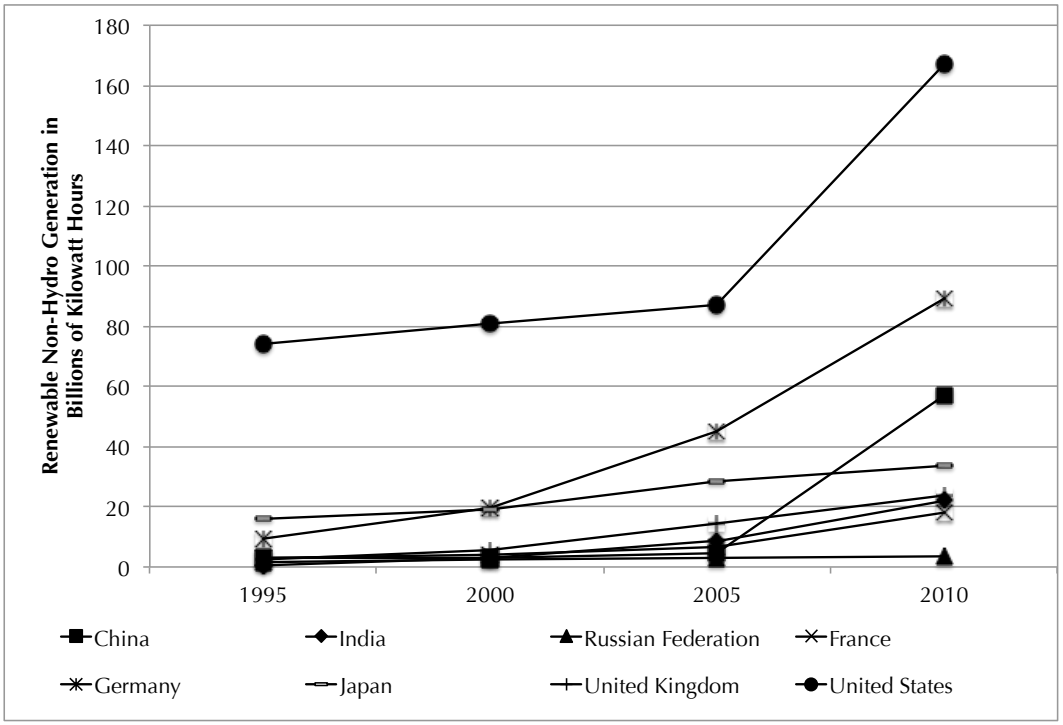
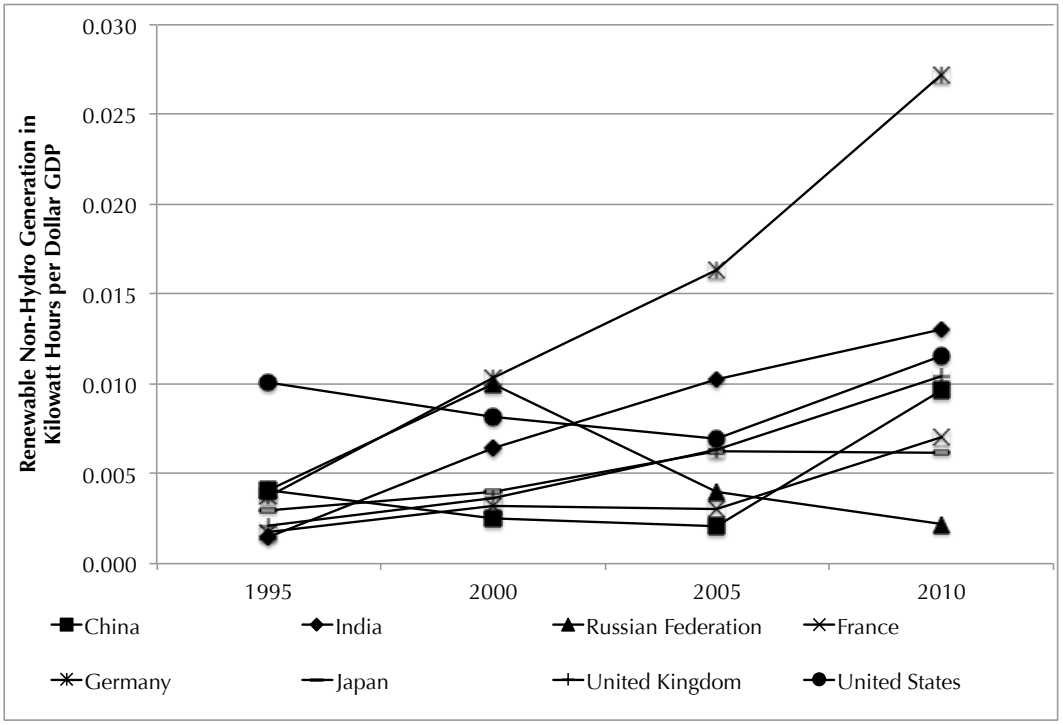


Figure 11: Renewable Electricity Generation per Unit GDP, 1995-2010[241]



[240] USEIA, "Total Non-Hydro Renewable Electricity Net Generation." (Non-hydro renewable generation.)

[241] Ibid.; World Bank, "GDP (current US$)." (Non-hydro renewable generation.)

In contrast with data on the fossil fuels industry, data on renewable energy generation does suggest real evolution. Renewable energy generation is growing unambiguously in all key players except Russia. In absolute terms, its percent growth since 1997 has been largest in China; in relative, per-unit-GDP terms, it has grown particularly strongly in Germany, India, the UK, and France. The renewable energy industries of the US and Japan also show fairly strong growth in both categories.[242]

Returning to a subset of the index data used in the single-round analyses above gives a closer look at green product manufacturing, as a supplement to generation data. The numbers are subsets of the simple index scores given above, specifically for the characteristics that speak to strength in manufacturing activity (production of solar equipment, wind equipment, and ethanol); scores range from 0 to 3. The data suggests a growth picture for China and India; and some fall-off for Japan. The US and EU are strong throughout; given increasing global competition from China and India, this still implies significant *absolute* growth in US and EU renewable manufacturing.

Table 7: Renewable Industry Index Scores (Manufacturing Only), 1997 - 2009[243]

	Renewable Manufacturing Index Score		
	1997	2009	Change
United States	3	3	**0.0**
China	0	2	**2.0**
EU	2	2	**0.0**
Japan	1.5	1	**-0.5**
India	0	1	**1.0**
Russia	0	0	**0.0**
Brazil	1	1	**0.0**

The trends seen in green generation and green manufacturing overall provide evidence for some level of industry reconfiguration, especially in China and India, and to a lesser extent the US and EU (where renewables were already strong but have grown in size). But how important is it, and does it suggest structural changes to the aggregate industry interest configurations of key players?

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[242] US growth appears relatively low on this chart because as a proportion of installed base in 1995 it is much lower than the growth of countries like China and India. I measure growth as a proportion of installed base in 1995 since I am interested in relative changes in industry interests; a country that increases its installed base 50-fold is likely undergoing a bigger shift in relative interests than a country that increases its installed based by 50 or 100%. Pairing this measure with the per unit GDP measure balances it with a sense of the general importance of renewable generation to the economy.

[243] These index scores are taken from the same index used to create the 1997 and 2009 single-round analyses of existing interests; they summarize domestic green industry using scores for strength in solar, wind, and ethanol production.

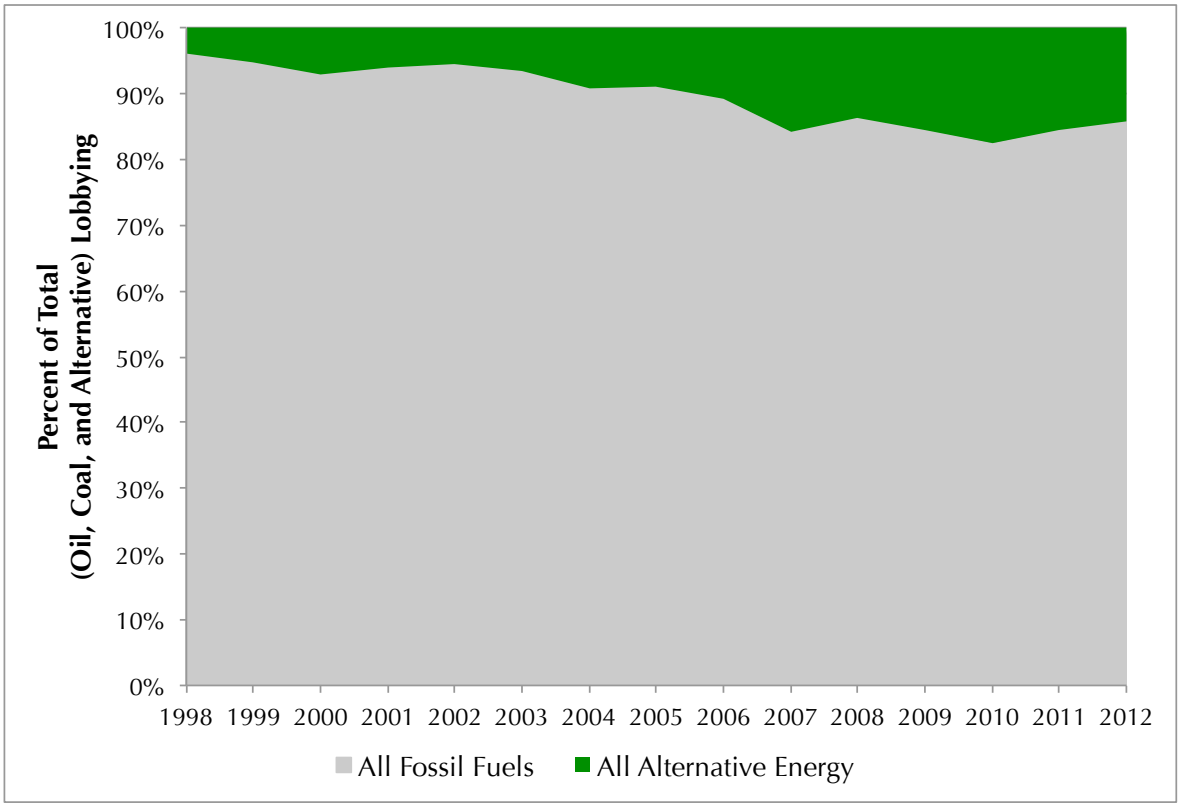
Marginal Shifts, But No Structural Reconfiguration

Evidence suggests the answer is no. Structural reconfiguration occurs when the configuration of industry interests alter such that the aggregate influence being exerted on policymakers by industry changes in ways that allow for shifts in position. Here, I argue that this has not happened in climate. I first take a deeper look at industry influence in the form of lobbying in the US. I then briefly examine the EU and China. For reasons distinct to each party, interests do not appear to have shifted structurally in ways that change the potential for a climate deal – though China is an arguable exception, very recently.

Industry Interest and Influence in the United States

Figure 12 juxtaposes total US lobbying spending by fossil fuel and alternative energy-based companies, from 1998 to 2012.[244] Alternative energy lobbying has in fact increased substantially, from $2.4 million in 1998 to $32.8 million in 2009, as we would expect given that green industry in the US has grown in absolute terms between Kyoto and Copenhagen. But fossil fuel spending has also increased, from $60.4 million to $178.5 million. The net effect has shifted the ratio of spending: in 1998 the ratio of fossil fuels dollars spent for every renewable dollar was $25.1 : $1; by 2009 it was only $5.4 : $1.

Figure 12: Share of Energy Lobbying Spending, 1998 - 2012[245]

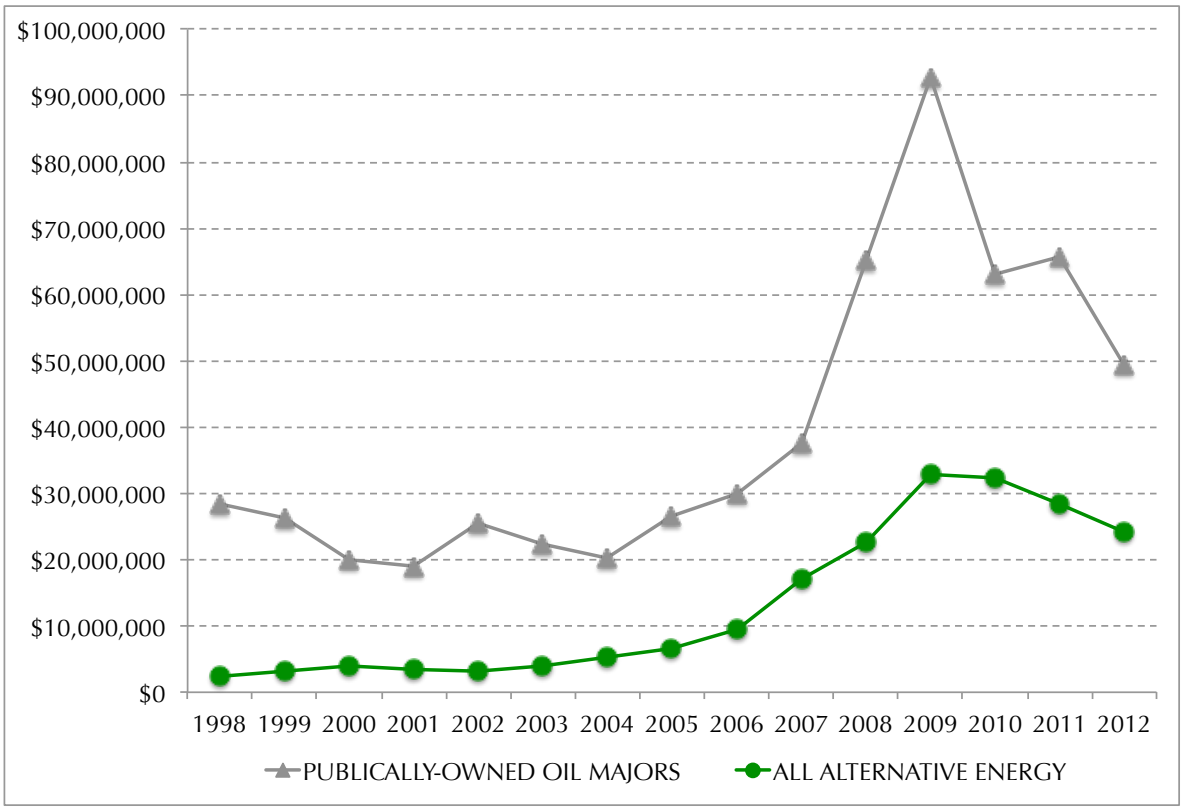


[244] Data for 1997 was not available.

[245] Center for Responsive Politics, "Oil & Gas"; Center for Responsive Politics, "Alternate Energy Production & Services."

But although this is a real change, it is marginal rather than structural change. Fossil fuel influence still clearly has the upper hand; it merely dwarfs renewable influence by a somewhat smaller margin. Moreover, fossil fuel industry lobbying is significantly less fragmented than the renewable industry. The various fossil fuel industry companies have broadly related interests. There is a split between coal and oil, but oil alone makes up the majority of fossil fuels lobbying. The subsets of renewables – wind, solar, and so on – are politically associated, but may or may not benefit from precisely the same policies, and are less likely to be strongly connected institutionally. Figure 13 makes this point simply:

Figure 13: Lobbying by Publically-Owned Oil Majors vs. All Alternative Energy[246]



Even in recent years, spending from the five (very large, very similar) publicly owned oil companies *alone* is roughly double that of *all* alternative energy lobbying spending. In short, alternative energy lobbying spending has been and remains significantly weaker than fossil fuels both in terms of its total size and in terms of its likely potential to wield that power in a concerted way.

I want to avoid suggesting here that US aggregate industry influence simply collapses to what oil majors want and regulation is therefore impossible. Rather, it would be more accurate to say this: the oil majors do not want regulation, *and* their absolute

[246] Center for Responsive Politics, "Oil & Gas"; Center for Responsive Politics, "Alternate Energy Production & Services."

ability to exert influence to defend that is not currently declining; meanwhile the ability of industries with interests in regulation to exert influence *has not yet* grown enough to provide an effective counterweight. That could change if a) the absolute size of fossil fuel interests begins shrinking, b) green industries grow even bigger and become more of a contender, or c) other large industries develop novel interests in green regulation and begin lobbying for regulation. Some of these possibilities are obviously interconnected. For instance, both (a) and (b) could happen as a result of acceleration in the addition of/conversion to renewable generation. In Chapter 5, I explore the idea of local green spirals; such local feedback processes are one way that green industry could build up sufficiently to begin challenging fossil fuel interests at the national level.

Industry Interests in Other Key Players

Data limitations prevent a similar detailed analysis for the remaining key players, but we can look broadly at these other players as well.

The EU's evolution does not constitute a structural change for a different reason: because it has taken Europe in the direction it was already trending, but has not given Europe the power to take other players with it. The importance of fossil fuels industries to Europe were already comparatively low by 1997. Europe has been able to achieve a slight drop in fossil fuels dependence; its green industries continue to grow in absolute size; and its member states show strong growth in renewable generation. But since the EU was already in the pro-regulation camp, this does not grow the pro-regulation coalition. By 2009 Europe did want a deal even more strongly than it did in 1997 – but it still didn't have the power to get one unilaterally.

Meanwhile, the dynamics in key developing players, China and India, face a fundamental constraint in the form of rapid growth trajectories. In China (and to a much lesser extent in India) we have seen a real shift toward renewable industry. China has gone from a near non-participant in solar and wind in 1997 to arguably the number one player globally in both.[247] This shift means an evolution in interests, which can be seen in the importance China accords renewables in its industrial planning recently. China's 12th Five Year Plan emphasized the environment and energy efficiency generally, and specifically identified energy savings and environmental protection, new energy (nuclear, wind, and solar), and clean energy vehicles as three of seven priority industries for development[248].

But China's rapid development imposes fundamental constraints on its industry interests. China is growing fast enough that it needs to grow both green and brown generation as fast as it can to maintain its current pace.[249] Although its renewables industries are growing and energy efficiency is improving rapidly, China's fossil fuels usage is also shooting upward in absolute terms. In a sense, China can be viewed as

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[247] China took clear leadership in both wind and solar around 2009-2010 ("Wind Turbine Manufacturers - Global Market Shares"; Earth Policy Institute, *Annual Solar Photovoltaics Production by Country, 1995-2012*; Fraunhofer Institute, *Fraunhofer Institute for Solar Energy Systems ISE: Photovoltaics Report*.) but in 2012 its dominance in wind fell off somewhat, partly due to slacker internal demand (Kaplan, *GE Surges in US, Captures 2012 Global Leadership*.).

[248] KPMG China, *China's 12th Five-Year Plan: Overview*.

[249] Chang and Gao, "China: Green Industry Growth in a Brown Economy."

experiencing both a "green" and a "brown" spiral simultaneously. Both sides of the energy industry look increasingly important to China's future growth.

As a result China's interests are moving away from solid opposition to carbon regulation, but remain ambiguous. A global climate deal could grow markets for the green exports China has targeted as growth opportunities, but accepting constraints on its ability to add brown energy to its economy cuts against other very strong interests it holds. As the single-round analyses suggested, China is moving into the ambiguous camp, but not yet into the pro-regulation coalition. (See Chapter 5 for more discussion.)

Meanwhile, India is less further along generally. It has not acquired the kind of manufacturing and export dominance in green industry that China has. On the other hand, it is at an earlier point in the build-out of its energy infrastructure and some types of green generation may offer it practical advantages.[250] It is unclear whether India faces the same structural constraints China has; but regardless, it is too early in India's growth trajectory for it to join the green coalition.

DISCUSSION AND IMPLICATIONS

We do not see a green spiral in climate change. Growth in pro-regulation industry interests has occurred on the margins, but Kyoto has not led to a fundamental reconfiguration of aggregate interests in key players. There has not been a significant shift over time in the political viability of increased international regulation among key players. Accordingly, climate change negotiations have failed to gain the momentum that characterized ozone negotiations. This is evidence is consonant with the importance of the green spiral mechanism.

This analysis thus provides an explanation of the failure of climate negotiations that differs from the standard treaty success explanations, and which has implications for future policy goals. If green spiral mechanisms (or the lack thereof) were important in both cases, policymakers should be thinking about these mechanics in future negotiations. Actors that favor regulation should be trying to focus on outcomes most likely to trigger these spirals.

So why do such spirals occur in some cases and not others? Why did the initial policy moves of the Kyoto Protocol fail to lead to major industry reconfiguration between rounds? What differences between ozone and climate account for this divergence? As I discussed in the introduction to this section, previous scholarship has focused on the structural issue of the scope and complexity of the climate problem. I have suggested that the local cases of successful green spirals in climate (discussed in detail in Chapter 5) suggest that the scope of the problem is not by itself enough to rule out a green spiral.

Rather, this international-level analysis suggests at least three factors that differentiate ozone and climate and have bearing on their differing outcomes. First, the sheer *scale of first-round policy stimulus* in the Kyoto Protocol (climate) was smaller relative to the problem than it was in Montreal (ozone). Second, the *type of policy stimulus* found in Kyoto was poorly designed relative to the problem at hand, which was a particularly serious problem given the small size of the stimulus. Third, there is a *structural*

[250] Sathaye and Mandell, "India: Can Green Be a First-Best Development Solution for Developing Countries?".

difference between the types of industries relevant to ozone and those relevant to climate change, which creates additional challenges in climate. Below, I discuss each of these issues in greater detail.

Insufficient Policy Stimulus

As a baseline, Kyoto's effects were destined from the start to be modest, because the Protocol itself was quite modest. By contrast, the Montreal Protocol, though still fairly moderate, demanded deeper initial cuts, creating a stronger stimulus. The ozone process and climate process both require(d) industry evolution and the consequent growth of political will between rounds of negotiation in order to make a full solution politically viable. But it is also true that the initial levels of political will that dictated the level of action achievable in round one was higher in round one of ozone than in round one of climate. This by itself is a problem, given that the industry reconfiguration required in climate is fairly significant.

Ineffective Policy Stimulus

But Kyoto's approach was not just weak; it was also poorly adapted to the problem at hand. It is possible that under the right circumstances, even quite weak stimulus might create the necessary shifts, simply more slowly. However, I suggest that Kyoto's approach was essentially (though certainly unintentionally) designed to further hamstring its effectiveness at initiating a green spiral.

Policymakers have tended to grapple with the climate problem as a problem of costs that must be minimized and distributed. With limited political will available, policymakers shaped a treaty that applied broad but very shallow requirements across most developed countries and with no particular industrial or economic targets. Domestic actors and commentators then grappled with these requirements to figure out how they could be accomplished with the least cost and disruption to business as usual. McKinsey's well-known Greenhouse Gas Abatement Cost Curve, which charted a range of measures from high net profit to high net cost, is an example of this paradigm. The report suggests that "the most economically rational abatement opportunities" might require incremental investment of only "5 to 6 percent of [business as usual] investment in fixed assets in each respective year," and that in fact "many of the opportunities would see future energy savings largely compensate for upfront investments."[251]

A primary policy framework through which this paradigm has manifested is the concept of carbon pricing. Carbon pricing instruments are popular because they are designed to minimize adjustment costs. They provide industry with incentives to identify and pluck "low-hanging fruit," delivering emissions reduction with high economic efficiency and minimizing the politically unpalatable costs of adjustment. For this reason, carbon pricing mechanisms are considered a first-best approach.[252] By the same logic,

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[251] Nauclér and Enkvist, *Pathways to a Low-Carbon Economy: Version 2 of the Global Greenhouse Gas Abatement Cost Curve*, 8.

[252] See for instance Böhringer, "The Kyoto Protocol: A Review and Perspectives"; Goulder and Pizer, *The Economics of Climate Change*; Nordhaus, *Life after Kyoto: Alternative Approaches to Global Warming Policies*.

direct regulation is generally to be avoided because it does not encourage the same efficiencies. In fact, the primacy of carbon pricing in economic analysis has been such that the primary debate is not between carbon pricing and other approaches, but over *which form* of carbon pricing instrument is most advantageous.

But I argue that if industry reconfiguration is necessary, and particularly if political will is low, least-cost paradigms like carbon pricing are precisely the paradigms that least effectively apply available political leverage to shift specific interests. Shifting concrete interests by nature demands costly readjustment and reinvestment. Industries must change where they have substantial sunk costs and sticky assets, which in turn means they have to substantially *sink costs*. Incremental investments – such as, for instance, installing equipment to make a legacy facility more efficient – often do not change the profile of industry's core interests (indeed, by disposing of the "low-hanging fruit" they may increase industry opposition to the next round of cuts). Hence, they do not move aggregate national positions.

Therefore, given limited political will, weak carbon pricing spends that political capital poorly. It produces very broad, very weak incentives spread shallowly across a large number of industries. This may shift many industries marginally, but is unlikely to shift any one industry or interest group a great deal, or create major new industries. Thus, it does not tend to break up anti-regulation coalitions or create major new interests for pro-regulation coalitions.

It may be more effective to use limited political resources in more targeted ways – such as regulation that is narrower but deeper, focusing on industries that have the highest potential for interest shift and applying as much leverage as possible in a focused way. I believe targeted regulation is critical; but subsidies and demand-creation strategies are also likely to be a part of that picture. Growing novel industries by providing subsidies aimed at commercialization (not just innovation – see discussion below) and creating demand with government or military purchasing programs requires less political capital to achieve (it is easier to defend giving out benefits than imposing costs), and has the potential to grow novel regulation-adapted industries, which could help kick off a spiral.

Where to Focus Policy: Structural Differences in Industry Configuration

I argue that policy must focus on high-potential industries; but what are these? An overview of climate suggests that carbon regulation affects a different mix of industry types than ozone did, and this has real implications for the initiation of a green spiral. This more subtle structural issue may be at least as important as the sheer scope or complexity of the climate problem. Consider two interrelated points, both of which differentiate climate from ozone: first, unlike in ozone, although there has been substantial new investment in green energy, in climate that investment has not been matched by disinvestment from brown energy. Second, in climate, in many important areas, the companies that make polluting products (fossil fuels producers) are not the same companies that make substitutes (such as wind and solar generating equipment).

I suggest that industries relevant to efforts at pollution control cooperation can be divided into four categories. Two of these categories are intuitive. First, **Losers** are industries that face serious disruption or death in the event of substantial pollution

regulation, typically because their products or processes are so pollution-intensive that regulation will cause significant, on-going costs (or total phase-out) and the producer has no obvious non-polluting substitute it can convert to. These industries naturally oppose regulation. **Winners**, on the other hand, have products or processes that are favored by regulation; they naturally support regulation.

The two additional categories are more complex. **Substitutable** industries are industries that are producing polluting products, but which have the capability to switch to production of non-polluting substitute products. These industries will tend to oppose regulation until they have made sufficient capital investment in new production capacity for substitutes; they will then become increasingly regulation-supportive. Finally, **Management** industries include industries whose primary interface with regulation is in the form of efficiency regulation or increased prices for inputs, which induce them to manage their usage of polluting inputs more carefully. Often these industries are users or indirect producers of a pollutant – such as manufacturing industries that use electricity for manufacturing. These industries tend to moderately resist regulation due to aversion to up-front costs, but not as strongly as Losers because regulation does not constitute an existential threat. However, unlike Substitutable industries, Management industries' baseline incentives do not change when they respond to regulatory pressure, because the changes they make tend to be marginal changes to processes and input usage, rather than structural changes to businesses, and hence do not change their core interests.

Table 8: A Typology of Industry Positions on Regulation

Industry	Losers	Winners	Substitutable	Management
OZONE				
CFC Production			**X**	
CFC Industry Users - Refrigeration, etc.			X	
Agriculture (late-stage entrant)	X			X
CLIMATE CHANGE				
Petroleum & Gas Prod'n and Processing	**X**			
Agriculture - Livestock	X			
Cement	X			
Some Heavy Industry (e.g. Iron & Steel Production)	X			
Renewable Energy & Green Products		**X**		
Agriculture - Crops		X (biofuels)		X (other)
Power Generation			**X**	
Transportation			**X**	
Grid Technology			X	
Chemicals			X	X
Buildings/Building Management				X
Other Industry and Manufacturing				X

This typology suggests a novel way of thinking about the structural difficulty of international environmental treaty making. In the case of ozone, the key industries affected (especially in early rounds of negotiation) were CFC producers and manufacturers of CFC-using equipment. Because substitutes existed, and could be produced and used by the *same* industries producing and using CFCs, these industries were largely Substitutable. Early regulation in the Montreal Protocol initiated a process of new capital investment that converted these industries from producers of pollutants to producers of regulation-adapted products, changing their interests. In contrast, climate contains several large, important Loser industries. Alternative energy equipment does not draw on the same technological strengths as fossil fuels production, so fossil fuels producers are unlikely to be able to adapt easily. Instead, shifting interests around fossil fuels may mean phasing out fossil fuels industries and growing separate Winner industries like solar and wind.

I argue that the potential for green spirals is partially dependent on the balance of Winner, Loser, and Substitutable industries in an issue area. Converting Substitutable industries is likely to be an easier task than shrinking Loser industries while growing separate Winner industries, since industries facing an existential threat will naturally be strongly resistant to regulation, and it is likely that novel Winner industries will take a fair amount of time to grow into political contenders. Climate's structural difficulty, I argue, is at least as much about this issue as it is about the sheer size of the problem.

This analysis also suggests that Substitutable industries should be identified and targeted by policy actors that want to support policy-industry feedback processes. Substitutable industries represent soft points that are most vulnerable to leverage, because policy could convert these large existing industries into supporters. In climate, there are some Substitutable industries: they include electricity producers, which can shift investment from fossil fuels to renewable generation assets; grid equipment producers, if they can offer more sophisticated "smart grid" products; and transportation, where automobile manufacturers who shift investment to production capacity for electrical or alternative-fuel cars will have interests in policy supporting the sale of such cars.

Additional Points

The Role of Investment and Sunk Costs: Investment vs. Innovation

The discussion above focuses a great deal of attention on sunk costs and concrete capital investment. The international relations literature on factors that cause shifts in material interests is comparatively sparse, but one exception from the realm of international political economy is the literature on innovation as a source of changes to interests and preferences. However, in both the ozone and climate cases innovation alone appears insufficient to trigger shifts in concrete industry interests.

Only when industry has concrete green capital investment to defend, in amounts that are significant relative to prior sunk costs in brown investments, is its position likely to change. In the ozone case, alternatives to CFCs were largely developed in the 1970s, but shifts in industry interests in most countries did not occur until the Montreal Protocol triggered concrete capital investments in large-scale substitutes production. In the complementary climate case, there has actually been an amazing amount of innovation in

low-carbon systems development. Workable solutions exist to provide non-fossil fuels power. They remain more costly than fossil fuels power, but even costs are falling over time. Moreover, in ozone, too, solutions were more costly throughout the negotiations, which suggests that within reasonable limits, the cost of solutions is not an insurmountable obstacle. Nonetheless, in climate the mere existence of solutions has not substantially altered aggregate national positions. The existence of solutions is certainly a permissive condition, but it is not the whole story.

Tipping Points

My analysis suggests a tipping point dynamic at work in the green spiral. Not all changes in interests constitute structural reconfiguration; shifts must aggregate to the point that they provide a basis for movement of specific companies or industries out of anti-regulatory coalitions and/or into pro-regulatory coalitions. In ozone, interests were fairly close to the tipping point and comparatively easy to push over it. In climate, interests appear to require more evolution to get them to that point. This suggests, not that a green spiral is impossible in climate, but that it is likely to be a longer process that requires better tailoring of policy to produce effects. It is possible that if policymakers consciously focus more on targeting measures that apply maximum leverage on well-chosen interests at minimum political cost, that process can be accelerated. And there is some evidence that evolution *is* beginning to occur, even if it has not reached the tipping point yet.

Competitive Dynamics

The role of competitive dynamics in green spirals is also of interest. These cases suggest that competitive dynamics can help or hurt green spirals, and there may be a window of opportunity for the former. In the ozone case, competitive dynamics were helpful. Early policy moves in the United States put DuPont a step ahead in adapting to ODS regulation, and created an incentive for it to support an international deal to level the playing field. That support split industry and helped to begin opening political space for regulation, in concert with other factors. When a deal is possible, competitive inequalities within industry may help push some industry players into supporting a regulatory deal.

Momentum and timing seems particularly key here, however. If a deal is not forthcoming, competitive dynamics may begin to sabotage existing or nascent policy-industry feedback dynamics. For instance, the failure of 2009 to produce any kind of binding agreement may be leading to an erosion in Europe's position on renewable energy and emissions reduction; as of January 2014 the EU was considering moving to non-binding rather than binding renewable energy targets for 2030, as Europe struggles with a sluggish economy and high energy prices while watching prices fall in the United States.[253]

[253] Oliver, "EU Considers Scrapping 2030 Binding Renewables Targets."

No International Spiral – but Local Spirals?

It is, of course, difficult to prove conclusively that lack of the policy-industry feedback process was a core causal factor for lack of progress in negotiations. The observed dynamics in industry and the observed correlation between industry interests and national positions at multiple points in the process – the corresponding lack of change in both – are consonant with such an explanation. Still, absent further evidence, the structural argument that climate change has not developed negotiation momentum because the issue area is just too difficult is, at the very least, more parsimonious.

But additional evidence is available. As I sketched out at the beginning of this chapter, the existence of policy-industry feedback spirals at the local level – in individual countries or even individual US states – provides a strong counter-argument to this view. Chapter 5 addresses this issue by looking more closely at several local cases.

CHAPTER 5: CLIMATE CHANGE – CASES AT THE DOMESTIC LEVEL

INTRODUCTION

This chapter has two purposes: to address one of the explanations that have been offered to explain negotiation failure in climate change; and to use specific cases to dig deeper into what makes green spiral dynamics work.

First, it ***addresses the critique of the climate issue that suggests the issue is simply too difficult to solve*** – that it involves too many industries, that carbon emissions are too deeply embedded in all parts of our economy, and hence, that regulation is too difficult to achieve because it runs in opposition to too many powerful interests. The relative difficulty explanation is on the surface entirely reasonable – the climate change issue really is more difficult. But as an explanation for failure, it runs aground on a simple fact: relatively aggressive carbon regulation regimes have in fact been created in specific local cases. These regulatory "success stories" are all the more interesting because they fly in the face of our current understanding of the global dynamics of environmental regulation. Most theoretical understandings of international environmental regulation suggest that unilateral regulation in pursuit of a public good is problematic.[254] States are expected to be wary of situations in which they bear the costs of regulation but reap no benefits from it, due to lack of cooperation by other actors. Additionally, unilateral regulation without cooperation from others is expected to lead to substantial relocation of emitting industries to non-regulating countries, taking both their emissions and their economic value with them, which is undesirable both economically and environmentally. These concerns over the irrationality of unilateral action and the problems posed by widespread free riding, which trace back to the work of Mancur Olson,[255] are why scholars of international negotiations around public goods have often focused on problems of participation, enforcement, and design of enforcement strategies as explanatory factor and solution,[256] while at the same time grappling with the inherent difficulties of large multilateral treaties with many participants.[257]

These issues, in combination with the general understanding of carbon regulation as a difficult issue with many natural opposing interests, suggest that isolated local regulatory success stories should not occur. But they do, and policy-industry feedback dynamics explain why. Local spirals of policy-industry feedback create local constituencies that are adapted to and even benefit from local regulation, which in turn

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[254] The exception is if unilateral regulation can unilaterally provide a solution that generates many or all of the desired benefits of remediation – in such a case unilateral regulation may be rational in a global context. However, this is not the case in climate change, where no one country can substantially solve the climate change problem on its own. Such a solution requires substantial cooperation from at least two and preferably all three of the US, China, and EU.

[255] Olson, *The Logic of Collective Action: Public Goods and the Theory of Groups*.

[256] Barrett, "On the Theory and Diplomacy of Environmental Treaty-Making," 326–327; Barrett, "The Strategy of Trade Sanctions in International Environmental Agreements"; Kahler, "Multilateralism with Small and Large Numbers."

[257] Kahler, "Multilateralism with Small and Large Numbers"; Olson, *The Logic of Collective Action: Public Goods and the Theory of Groups*.

helps to support the creation of additional regulation that provides further benefit. As a result, such regulation can become locally rational even though it appears globally irrational under our existing understandings.

Second, the ***presentation of a number of local stories (successes and failures) allows me to dig deeper into what makes a green spiral work or fail to work***. Thus, the second purpose of this chapter is to provide a broader and deeper look at the dynamics of green spirals, supporting richer discussion of its mechanism and policy implications.

Along these lines, this chapter also notes the issue of the complexity of the climate change issue. In ozone, we could explain much by looking at a single industry. In climate change, a broad variety of industries are potentially relevant – oil production and processing, manufacturing of various forms, power and gas utilities, building construction and land development, appliances and electronics, renewable energy products and generation, and many others. Thus, these local-level cases allow us to consider how green spiral politics can work in the context of a complex, multi-industry problem.

Policy-industry feedback has not previously been substantially utilized as an explanatory factor in examining international negotiation. However, policy-industry feedback processes do have some history of scholarship recently at the domestic level. As discussed in Chapter 2, a small set of recent literature deals with feedback processes at the local/domestic level. In the wake of the failed Copenhagen negotiations in 2009, the project leading to *Can Green Sustain Growth? From the Religion to the Reality of Sustainable Prosperity* began work on the local cases summarized in this chapter.[258] A number of these case studies drew directly on the green spiral concept, which was first presented in that book, as it applied to various national cases.[259] Eric Biber's[260] excellent work on the defeat of Proposition 23 in California advances a line of argument that sketches out essentially the same mechanism. It comes to some of the same conclusions (such as the importance of dynamic rather than static analysis, and the importance in policymaking of considering the potential impacts of current policymaking on future policy feasibility) suggested in Can Green Sustain Growth and developed more fully in this dissertation. Finally, there have also been a few pieces of work in the path dependence literature that have noted feedback processes in climate policy without fully engaging theoretically with the issue of precisely how feedback can lead to change.[261]

I begin this chapter by summarizing two "success stories" – California and Denmark. These are local cases in which green spiral dynamics have resulted in local carbon emissions regulation that is quite aggressive in comparison to neighboring policy norms. I describe how these spirals occurred – in some detail in the California case, and

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[258] Zysman and Huberty, *Can Green Sustain Growth? From the Religion to the Reality of Sustainable Prosperity*.

[259] Kelsey and Zysman, "The Green Spiral."

[260] Biber, "Cultivating a Green Political Landscape: Lessons for Climate Change Policy from the Defeat of California's Proposition 23."

[261] See for instance Jacobsson and Bergek, "Transforming the Energy Sector: The Evolution of Technological Systems in Renewable Energy Technology"; Stenzel and Frenzel, "Regulating Technological Change - the Strategic Reactions of Utility Companies towards Subsidy Policies in the German, Spanish and UK Electricity Markets". See my discussion of path dependence literature in my conclusion (Chapter 6) for more.

more briefly in the Denmark case. I then address two complementary cases – Japan, where the stage appeared set for a green spiral, but that spiral did not occur; and China, where something resembling a green spiral does seem to be at work but the different dynamics of a developing country setting complicate matters.

As noted above, this chapter draws in great part on the case studies completed in *Can Green Sustain Growth? From the Religion to the Reality of Sustainable Prosperity*[262], a project to which I contributed. This set of case studies illuminates a set of both successes and failures in local green policy attempts; and I am greatly indebted to the work of the other authors involved – particularly Alice Madden, Sean Randolph, and Juliana Mandell (California); Jakob Riiskjaer Nygård (Denmark); Mark Woodall (Japan); and Crystal Chang and Jany Gao (China).

CASE STUDY 1: CALIFORNIA

Case Background and Overview

Emissions regulation in California proceeds in three major phases, with one interstitial interlude. The initial description of these phases and the discussion of green energy and green venture capital growth draws partly on the United States chapter of *Can Green Sustain Growth?*[263] In that chapter, we broke the case into four phases plus a regulatory interlude around electricity deregulation; here I use a similar but somewhat condensed timeline.

In **Phase I** (1940s through 1973), California underwent particulate air pollution crises, prompting the regulation of polluting emissions in an effort to reduce smog. In the 1940s-1960s, California began experiencing dangerous levels of particulate pollution and smog. This crisis stimulated the ***creation and evolution of regulatory infrastructure***, in particular in the creation of the fairly independent and powerful California Air Resources Board (CARB). The establishment of powerful, independent regulatory infrastructure sets a precedent that continues down through California's regulatory history in subsequent phases,[264] leading to substantial piecewise direct regulation over subsequent decades. Both bureaucratic entities and legislators established ***new air quality regulations*** during this phase, particularly ***motor vehicle emissions controls*** like tailpipe emissions standards and mandates for innovations such as exhaust control systems in cars sold in the California market. ***Air quality standards*** were established for particulates, photochemical oxidants, sulfur dioxide, nitrogen dioxide, and carbon monoxide.

In **Phase II**, 1973 to roughly 2002, in addition to ongoing pollution problems, California faced and responded to a second type of crisis: oil price shocks occurred in 1973 around the OPEC embargo and in 1979 around the Iranian revolution. During this phase, CARB's regulation of emissions sources continued. One important set was the introduction of California's ***reformulated gasoline program***, which created a set of

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[262] Zysman and Huberty, *Can Green Sustain Growth? From the Religion to the Reality of Sustainable Prosperity*.

[263] Kelsey et al., "The United States: Local Green Spirals, National Ambiguity."

[264] Hanemann, Michael, "California's New Greenhouse Gas Laws."

specifications for cleaner-burning gasoline. CARB's specifications were implemented between 1992 and 1999, and required special modifications to refinery infrastructure. Additionally, *a* ***second layer of regulation was added that sought to increase efficiency*** in the use of electricity and gas, and reduce dependence on oil. ***Efficiency mandates*** for buildings and appliances were created and then expanded over time. Finally, the ***incentive structure of the utility industry was changed via "decoupling"*** for natural gas (1978) and electricity (1982). Under the new system, utilities make "rate cases" to the California Public Utilities Commission (CPUC) specifying the amount of revenue they need to cover investments, the amount of power or gas they expect to sell to customers during a particular period, and recommended power and gas rates. CPUC then sets rates for the utility that allows it to recoup costs and make a set profit. This process results in projected earnings for the utility. If, in practice, the utility exceeds projected earning (i.e. by selling more power than projected), the utility's excess earnings are returned to customers. On the other hand, if the utility undershoots its projections, it is allowed to recoup the missing earnings. This intervention removed business incentives that were in conflict with the success of efficiency programs, which the utilities were also tasked with; utilities could no longer do better by selling more energy, or worse by selling less.

At the end of Phase II, between the mid-1990s and 2001, California went through a period I refer to as the ***Deregulation Interlude***. This period is an isolated moment in the regulatory story, in that it does not directly impact emissions regulation. However, it occurs in conjunction with (and in some specific cases may accelerate the trends of) the last portion of the Phase II period. During it, partial deregulation of California's energy markets took place, leading to an energy crisis and financial disaster for many utilities.

Finally, in **Phase III**, from roughly 2002 to the present, California emerged from the energy crisis and entered a period in which significant carbon reduction legislation policy was created. Early moves in Phase III included Senate Bill 1078, which established California's first ***renewable portfolio standard (RPS)*** in 2002[265]. 2006's Assembly Bill 32 (AB32) mandated ***emissions reduction targets*** – to 1990 levels by 2020, and an 80 percent reduction from 1990 levels by 2050 – and led to a variety of subsidiary laws and policies. These include a ***cap-and-trade program*** covering electrical generating facilities and import, and some industrial sources; and, in 2015, additional industrial sources and transportation fuel; ***ramp-up of the Renewable Portfolio Standard for renewable generation (to 33% of total generation), light-duty vehicle GHG standards***, efficiency, etc.; ***low carbon fuel standards*** to reduce transportation fuel carbon intensity by at least 10% by 2020; and others.[266] California has also passed other measures, such as SB375, which concerns ***regional community planning issues that affect transportation emissions***. The 2010 challenge to AB32, Proposition 23, capitalized on the 2008 recession by calling for the suspension of AB32 until unemployment fell below specified levels – in practice, an indefinite suspension. The ***defeat of Prop. 23*** was therefore also an important policy moment.

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[265] CPUC, "California Renewables Portfolio Standard (RPS)."

[266] CARB, *Climate Change Scoping Plan: A Framework for Change*.

Summary of the Green Spiral In California

The overall upward trajectory of emissions regulation in California is a green spiral process. Two rounds of crisis (smog in the 1940s-1960s and oil in the 1970s) helped create viability for two rounds of direct regulation that effectively reduced air pollution and built constituencies that were adapted to emissions regulation. In turn, this evolution ultimately shaped industry interests in ways that helped create political viability for more aggressive regulation in the form of AB32, and defeated Prop. 23. Phase I policy moves created a strong, independent regulatory infrastructure. Phase II capitalized on regulatory infrastructure strength and crisis-generated momentum to begin the process of building green industry; began shifting the interests of large utilities in a pro-regulatory direction; and led downstream oil and gasoline producers to become somewhat regulation-tolerant over time, reducing overt opposition to subsequent policy. By the end of Phase II, California was beginning to see substantial adaptation of its industry to regulation. Many industries were, if not enthusiastic, at least accustomed to weathering California's rounds of regulation while continuing to profit. A few tentative supporters in green industry were emerging or being created by the end of this period.

During Phase III, industry reconfiguration came into its own. Many factors, including political and ideological tradition, existing regulatory infrastructure strength, and circumstance helped make the proposal and passage of AB32 possible.[267] I argue that one of those factors was the industry adaptation catalyzed in Phase II, which created a comparatively less oppositional industry atmosphere for such regulation than would likely have existed in other states. California's shift to light industry[268] and high-tech manufacturing, regulation-tolerant fossil fuels industry, regulation-adapted utilities, and growing green industry created a mix that didn't need to fight hard against AB32, and in some cases gave it support. AB32 had critics in industry – such as the Chamber of Commerce and the Western States Petroleum Association (WSPA)[269]– but they did not represent a unified industry position.[270] By the end of Phase III, the coalition of in-state interests willing to directly challenge regulation became relatively small, consisting primarily of isolated clusters of manufacturing, agriculture, and building industry interests supported by business interests that were out of state (coal) or recent entrants to the California markets ("Texas oil").

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[267] Hanemann, *How California Came to Pass AB 32, the Global Warming Solutions Act of 2006*.

[268] Kelsey et al., "The United States: Local Green Spirals, National Ambiguity," 132.

[269] Hanemann, *How California Came to Pass AB 32, the Global Warming Solutions Act of 2006*, 21.

[270] Eric Biber's case study of climate legislation in California (Biber, "Cultivating a Green Political Landscape: Lessons for Climate Change Policy from the Defeat of California's Proposition 23.") notes a contemporary source on opposition to AB32 (Thompson and Hubbard, "Oil Slick."). This source quotes Assembly Speaker Fabian Núñez on resistance from the oil industry and finds that oil companies gave $11.5 million to lobbying around AB32, of which $6.7 million came from the WSPA. The same article, however, notes much larger spending on other fights around the same time; and also notes a commentator from the Natural Resources Defense Council stating that the oil industry "didn't do a very public campaign." This matches my findings; searches of LexisNexis throughout 2006 did not yield any articles quoting the California oil majors taking any public position on AB32. The oil industry did not support AB32; but at the same time, they did not feel compelled to fight it publicly.

To some extent before but especially after AB32, green industry and related interests that benefit directly from green regulation grew strongly and emerged fully as an economic power to support carbon emissions regulation, alongside utilities. By 2010, with further investment in green industry, there was an active, vocal industry constituency fighting for the preservation of AB32.

In sum, regulatory moves in Phases II and III caused existing industries to adapt to a higher-regulation, higher-efficiency, lower-carbon environment. They led to the shrinkage and disinvestment of in-state interests with the desire to oppose regulation. And they led eventually to the significant growth of in-state interests that expected to benefit from carbon emission regulation.[271] It is important to note that early on, this process emerged largely organically from initial regulatory moves in tangentially related issue areas; it was not for the most part a planned or intentional process.

Evolution of Key California Industries through the Regulatory Phases

In this section, I examine a set of industries that played an important role in supporting or opposing various stages of regulation in California. I will show that in several key industries, evolution occurred between regulatory rounds, in response to regulation, which led to increasing political viability for ever-more-stringent rounds of regulation. Of course, there are external drivers, even late in the regulatory game, that have also played an important part. But overall, enough shifts have occurred out of the active opposition camp and/or into the active support camp to create a viable coalition today for comparatively strong carbon emissions regulation; and this is due in great part to policy-industry feedback processes.

Clean Energy, Cleantech, and Green Venture Capital – Growing Core Supporters

Regulation in both Phase II and Phase III has led to unusually high growth in the most obvious core Winner constituency for carbon emissions regulation: green energy and clean technology. Early growth during Phase II, due both to a friendly regulatory environment and resources in innovation, led to early California leadership in the green energy industry. Although green energy industries were not as directly involved in the formation of AB32 as they were later, a legislative package that would support a future growth industry California was already showing strength in has obvious attractions and fits with California's historical trajectory of environmental action. Certainly, the strong growth of green industry after the passage of AB32 fed back into the system again during Phase III, helping to build a constituency to defeat Proposition 23.

Three overarching trends came together to drive growth in this sector in California before and during Phase III. One is the green spiral process, internal to the regulatory story; two are external factors that accelerated this process.

[271] Eric Biber (Biber, "Cultivating a Green Political Landscape: Lessons for Climate Change Policy from the Defeat of California's Proposition 23.") comes to essentially the same conclusion regarding the effect of early policy moves on later policy viability in California, especially with regard to the defeat of Proposition 23.

Green Regulation and Green Industry Growth

By the end of Phase II and the beginning of Phase III, California was already a leader in green industry, partly due to its regulatory environment. California's incentives for green energy in Phase II were not yet strong enough to lead to serious growth in absolute numbers in the industry, but they played a role in pushing California ahead of the pack[272]. California was well ahead of any other state in installing the first large-scale solar generation facility: the Solar Energy Generating Systems (SEGS) plants, begun in 1985 and completed in 1991[273], were the world's largest solar thermal project at the time[274], and remained the only one recorded in EPA data until 2001[275]. California's first grid-connected solar photovoltaic (PV) projects also began in the 1980s, with the first large-scale PV projects (still quite small in absolute terms)[276]. The California Energy Almanac's summary of photovoltaic capacity, which includes smaller grid-connected capacity like residential systems, but does not include solar thermal, finds almost 200 megawatts of cumulative PV capacity installed by 2005, the year before AB32[277].

California's wind energy industry was also a leader within the US during and at the end of Phase II. According to EPA data[278], in 1990 California had 78 wind generation facilities (no other state was in double digits) and 98.6% of US nameplate wind generation capacity. Other states began catching up in the mid-1990s, but even as of 2002 California had 44% of wind generators and 38.4% of nameplate capacity (as compared to around 13% of US GDP).

Of course, some of California's early rounds of industry growth have not survived in their original form – for instance, Luz (the solar plant developer responsible for SEGS) filed for bankruptcy in 1991[279]. But while individual companies come and go, overall, the green industry grew and became more entrenched from the mid-1980s onward. Once installed, generation capacity like SEGS continues to operate even if it changes hands.

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[272] For instance, Wiser & Pickle find that "California has a market environment and set of public policies and market rules that, while not perfect, are more conducive to green power marketing than many other states. In fact, a critical finding of this report is that, because of the high cost of acquiring and servicing residential customers and the low utility default service price, green power marketing affords new energy service providers one of the only viable entrees to California's residential marketplace." (*Selling Green Power in California: Product, Industry, and Market Trends*, vii.) Henry Price ("Parabolic Trough Solar Power for Competitive U.S. Markets," 2.) notes with regard to California's first major solar generating plant, "The [SEGS] projects were initially driven by the availability of state and federal investment tax credits. Later, special power purchase contracts available in California played a key role."

[273] Cleveland, "Solar Energy Generating System (SEGS)."

[274] Sullivan, "Solar Energy Gets a Boost from Flurry of Designs"; Price, "Parabolic Trough Solar Power for Competitive U.S. Markets."

[275] EIA, "Existing Capacity by Energy Source, by Producer, by State back to 2000 (annual Data from the EIA-860)."

[276] California Energy Almanac, "California Solar Photovoltaic Statistics & Data: Solar Photovoltaics 1981 through 1997"; Go Solar California, "History of Solar Energy in California."

[277] California Energy Almanac, "California Solar Photovoltaic Statistics & Data."

[278] EIA, "Existing Capacity by Energy Source, by Producer, by State back to 2000 (annual Data from the EIA-860)."

[279] Parrish, "How Sun Failed to Shine on Solar Firm's Dreams."

And recent stronger regulatory support may be leading to more stability; a 2011 analysis finds solar installers active between 1998 and 2006 have largely survived and continued to do business, though with some churn[280]. A Next10 report on the cleantech industry finds that cleantech investment is increasingly aimed at deployment rather than development and growth, suggesting industry maturation[281].

California's nascent green energy industry in 2006 helped make AB32 attractive, as a legislative package that would drive growth in a future industry that California already had leadership in. And once AB32 was in place the effect on industry size was significant. California's cumulative grid-connected photovoltaic capacity doubled between 2006 and 2008.[282]

California's Innovation and Venture Capital Infrastructure

In addition to the accelerant effects of regulation, the growth of the green energy and cleantech industries in California benefited during Phase III from pre-existing economic infrastructure in the areas of innovation and venture capital investment. This dynamic is explored by Kelsey et al.[283] California has strengths in research and development, which supports its entry into new industries that require significant technological innovation. This innovative infrastructure simply makes green industry an easier play for California than for many other states. Equally importantly, at the beginning of Phase III, California's large and active venture capital community was emerging from the information technology bonanza of the previous decade. This created a vacuum that investors looked partly to green industry to fill[284]. The ready availability of venture capital funding made industry growth easier during Phase III[285].

External Assistance – Synergy with Federal Funding

Thirdly, again during Phase III, the availability of extensive funding from the federal government's stimulus package following the 2008 recession accelerated green industry growth. Partly due to California's existing expertise in cleantech and receptive investment environment, California has captured an outsized portion of federal funding green stimulus funding during the peak years of the stimulus package – more than any other state in renewable energy, grid modernization, and science and innovation,[286] as well as substantial energy efficiency program funding. This funding was synergistic with cleantech

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[280] Merry, "Top Ten California Solar Installers 2001-2006 (Where Are They Now?)."

[281] Next 10, *Cleantech Investment: A Decade of California's Evolving Portfolio*, 4.

[282] California Energy Almanac, "California Solar Photovoltaic Statistics & Data."

[283] Kelsey et al., "The United States: Local Green Spirals, National Ambiguity," 133–135.

[284] Ibid., 134.

[285] (Ibid., 135–136.) Though venture capital's relevance is winding down now, as it becomes more apparent that the time frames and types of return generated by green energy are not very well suited to the venture capital model (Ibid., 139–140.). Venture capital may continue to play a role in green industry but its applications going forward will likely be more restricted – for instance, to grid technology components rather than massive solar power projects.

[286] Kelsey et al., "The United States: Local Green Spirals, National Ambiguity," 136.

investment; for instance, a number of large DoE loans went to cleantech VCs[287]. All of this funding supercharged green energy and cleantech growth just before Proposition 23 appeared on the scene in 2010.

The Growth of Green Industry as a Political Force

As a result of these factors, the green energy and cleantech sectors have been a growing presence in the coalition supporting emissions regulation. They were already a nascent constituency by the end of Phase II, assisted by early pollution reduction and green energy regulation. They took off and became serious players during Phase III, due to regulation (both AB32 and the pre-AB32 RPS) and an influx of expertise and money from VC and federal stimulus funding. In 2008, California accounted for 50 percent of global cleantech venture investment, and 70 percent of US cleantech venture investment; it was the leader in US cleantech patenting between 2007 and 2009.[288]

Green industry was still emerging pre-AB32, and many factors were involved in the passage of that legislation. However, some policy actors commenting on the passage of AB32 credit the presence of green industry – venture capital, the clean technology industry, and pro-regulatory business communities – as an important factor in the pro-regulatory coalition.[289] The VC community wanted, and advocated for, a market for clean-tech and a regulatory environment that would ensure stability of expectations.[290]

The continued growth of these industries post-AB32 ultimately created a more substantial constituency that helped defend AB32 from the 2010 Proposition 23 challenge. A BACEI report estimates that green business in California grew 36 percent between 1995 and 2008, and grew 5 percent during the 2007-2008 recession, when total state employment *dropped* 5%.[291] Eric Biber's[292] work focuses on an in-depth analysis of the defeat of Proposition 23. His conclusion is identical to mine: industry feedback dynamics were critical in creating the Proposition 23 opposition (pro-regulatory) coalition. State industry interests that benefited from the continuance of green policy grew during this period. Such interests include not only green industry itself, but also growing green employment, which may have contributed to voters' willingness to believe arguments that AB32 was good – rather than bad – for employment growth. Biber notes that green industry and cleantech venture capital funding was only one factor, and represented a minority of donations to No on Proposition 23. Nonetheless, the investment industry did represent a meaningful portion of the coalition and leadership defending AB32, and it provided a particularly visible pro-AB32 faction within the business community. The No on Proposition 23 campaign was co-chaired by Tom Steyer, founder of Farallon Capital

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[287] Ibid.

[288] BACEI, *Global Competitiveness, China and California's Emerging Clean Energy Economy*, 12.

[289] Knox-Hayes, "Negotiating Climate Legislation: Policy Path Dependence and Coalition Stabilization," 555–556.

[290] Kelsey et al., "The United States: Local Green Spirals, National Ambiguity," 135.

[291] BACEI, *Global Competitiveness, China and California's Emerging Clean Energy Economy*, 4.

[292] "Cultivating a Green Political Landscape: Lessons for Climate Change Policy from the Defeat of California's Proposition 23."

Management; he donated $5 million to the campaign[293] and later spearheaded the creation of Californians for Clean Energy and Jobs, to push for "greater investment in green technology and the enforcement of the global warming law, known as A.B. 32" and resist efforts to limit the US EPA's efforts to regulate GHGs.[294] John and Ann Doerr (venture capital), Vinod Khosla (venture capital), Julian Robertson (hedge funds), and William Patterson (private investment) were also major donors to the campaign against Prop. 23.[295] Reporting from 2010 tends to focus on Silicon Valley and venture capital as the core of business opposition to Prop. 23.[296]

In sum, the growth of green industry interests with direct interests in carbon emissions regulation has been one of the core strands of the California green spiral story. This story begins with moderate regulation and initial growth in Phase II; it both supports and is further accelerated by Phase III regulatory moves.

Utilities – Turning Opposition into Support

Another particularly clear case of evolution is that of California's large investor-owned utilities – in particular, Pacific Gas & Electric (PG&E) – and the impact of decoupling and shifts in generation asset base.[297] This is also the one industry in which industry evolution was planned – regulators explicitly intended when they took action not just to change behavior but also to shift utilities' interests over time.

Utility evolution began in response to regulatory moves in Phase II. The decoupling of utility earnings from total gas and electricity sales (described above) removed an incentive to focus on increasing power usage to drive revenue. It took some time for utilities to fully adapt to this new paradigm; as late as 1988 PG&E's annual report[298] still focuses on sales and growth in reporting to shareholders.[299] Decoupling removed the

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[293] Marinucci, "Shultz, Steyer Join Forces to Battle Prop. 23."

[294] Woody, "Group That Beat Back Proposition 23 Is Reborn."

[295] Cal-Access, "Campaign Finance: Proposition 023 - Suspends Air Pollution Control Laws Requiring Major Polluters to Report and Reduce Greenhouse Gas Emissions That Cause Global Warming until Unemployment Drops below Specified Level."

[296] This passage from an LA Times article in October 2010 is typical, suggesting that AB32 "has solid support from venture capitalists…" and "Silicon Valley high-tech companies and entrepreneurs also embrace the law as an incentive to make California a world leader in renewable resources, including solar and wind power." (Lifsher, "Ballot Initiatives Divide a Usually United Business Front.")

[297] Biber also notes the importance of the shift in interests of the California utilities (Biber, "Cultivating a Green Political Landscape: Lessons for Climate Change Policy from the Defeat of California's Proposition 23."), for similar reasons; although, as discussed below, I would stress the importance of deregulation as a disruptive event mores strongly in the utilities story.

[298] PG&E, "Pacific Gas and Electric Company Annual Report 1988."

[299] The Letter to Shareholders from the Chairman and CEO of PG&E puts PG&E's efforts to "retain and build market share" front and center, as well as earning "a full authorized return" on equity invested, "rigorously controlling costs," retaining "$50 million of sales," and getting "attractive natural gas prices;" PG&E was also looking to "extend [its] business horizons beyond PG&E's regulated utility markets." All of the above resulted in "increased sales and total gas deliveries in 1988." (Ibid., 2–3.) This is the language of a company that hasn't yet figured out what its real value proposition for investors is *within* its existing regulated environment.

incentive structure that originally created business practices focused on total sales; but it didn't explicitly provide a *new* paradigm through which utilities could explain their value to investors.

Interestingly, the deregulation interlude, though not directly an emissions- or efficiency-targeted regulatory round, may have played a critical role in utility evolution at the end of Phase II. At the beginning of the deregulation experiment, utilities were encouraged to sell off their generation assets to independent power producers. Both PG&E and SCE, the two largest public utilities, sold some of their generation assets. PG&E in particular sold its thermal generation – such as an elderly Moss Landing gas-fired boiler plant that it sold to Duke Energy – emerging with a local generation portfolio that was heavy on nuclear, large hydro, and some smaller renewables. PG&E retained or subsequently acquired some natural gas generation assets as well, but was still able to boast that it had the lowest carbon emissions per generation of any large public utility in the nation.[300] The picture is a little less clear for SCE, which sold off its natural gas plants but retained two coal plants (high emissions), two nuclear plants (low emissions), and California's first large-scale solar installation (renewable).

The deregulation period may also have helped utilities finally make the transition to a new paradigm around efficiency programs. PG&E credited its efficiency programs with helping it avert the worst of the rolling blackouts late in the crisis; these programs went on to become one of the three key drivers of earnings PG&E routinely discusses in its annual reports.

In other words, decoupling initiated a process of evolution in the business model of California's large, investor-owned utilities. A full transition, however, does not seem to have been achieved until the disruptive effects of the deregulation period opened a window for a paradigm shift in utilities' business models. This seems to have happened at PG&E, in particular, and to a lesser extent at other utilities. PG&E in particular was a supporter of AB32,[301] and this appears to trace directly to the shifts in paradigm that it has undergone between 1978 and the present. By 2006, PG&E stated in its report that it was unconcerned about AB32 due to its existing asset base and business model:

> "The Utility's existing and forecasted emissions of greenhouse gases are relatively low compared to average emissions by other electric utilities and generators in the country, and the Utility's incremental costs of complying with greenhouse gas emissions regulations being promulgated by the CPUC and other California agencies are expected to be fully recovered in rates from the Utility's customers…" [302]

Peter Darbee, the chairman, CEO, and president of PG&E, stated in 2009, "I think the biggest key to the success in California was putting in place the right incentives for California utilities… all of a sudden you've unleashed the power of these huge organizations to work with you rather than against you."[303]

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[300] PG&E, "PG&E Corporation 2003 Annual Report," 3.

[301] PG&E, "PG&E Corporation Annual Report 2006," 3.

[302] Ibid., 63.

[303] Brownstein, "The California Experiment."

The transition to a business model that focuses on efficiency programs as valued asset was reinforced in Phase III, following AB32, with the introduction of "decoupling plus" policies. Decoupling plus provides material incentives and penalties to utilities to meet efficiency promotion targets – they pay a penalty for failing, but are allowed to directly capture some of the resulting gains if they succeed – and thus allows them to generate earnings from these efforts.

In essence, utilities in California behaved as Substitutable industries, as classified by the typology in Chapter 4. By the time Proposition 23 was on the ballot, large utilities in California seem to have firmly transitioned into a regulation-adapted paradigm. All three of California's largest utilities (PG&E, SCE, and San Diego Gas & Electric Co.) opposed 23.[304] PG&E provided material support to defend AB32, donating $500,000 to campaigns opposing Prop. 23.[305]

Oil and Gas – Creation of Regulation-Tolerant Constituencies

Background

During Phase II and III, California's oil industry became the dog that didn't bark.[306] As described in the overview above, in 2006 AB32 (a major carbon reduction bill) was passed; and then challenged by Proposition 23 in 2010, which would have suspended AB32 indefinitely. At the time, the popular understanding of the dynamics of Proposition 23 was that it was funded largely by out-of-state interests like Tesoro and Valero ("Texas oil") and unopposed by in-state interests, including California oil. If accurate, this begs the question of why local interests didn't oppose regulation while "Texas oil" did.

But I would argue that this is not a precise characterization. In fact, it would be more accurate to look at the divide as one between old and new entrants to the California economy. Veterans were regulation-tolerant while newcomers were strongly opposed. Understanding the real picture of the evolution of the local oil and gasoline industry in California involves looking more deeply at what happened to the industry between the 1980s and the late 2000s (in other words, Phase II and Phase III).

California's downstream oil industry is concentrated in a few major players. Only one (Chevron) is "local" in the sense of being headquartered in California. The others – British Petroleum (BP), ConocoPhillips, ExxonMobil, Shell, Tesoro, and Valero – are all headquartered outside the state. However, all these major players had substantial refinery holdings in California as of the passage of AB32 in 2006.

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[304] Lifsher, "Ballot Initiatives Divide a Usually United Business Front."

[305] Cal-Access, "Campaign Finance: Proposition 023 - Suspends Air Pollution Control Laws Requiring Major Polluters to Report and Reduce Greenhouse Gas Emissions That Cause Global Warming until Unemployment Drops below Specified Level."

[306] Again, Biber (Biber, "Cultivating a Green Political Landscape: Lessons for Climate Change Policy from the Defeat of California's Proposition 23.") makes a broadly similar point regarding the retreat of the "in-state" oil industry from opposition to climate legislation as a response to prior policy; Biber's account more heavily emphasizes the potential role of prior efficiency investments by companies like Chevron, and the particular mix of products produced by Valero and Tesoro vs. other California oil refiners.

These players are affected by three major areas of regulation – two environmental and one general. First, refineries bear direct regulation on process emissions from plants, in pursuit of air quality goals. Second, the formulation of fuels produced by refineries is controlled; CARB has gone through several rounds of clean gasoline regulation. The clean gasoline mandated by these regulations is fairly specific to the California market, and is often referred to as "CARB gasoline." Most major refineries in California have been (re-) configured to produce CARB gasoline, which is largely produced in-state and is largely limited to the California market where it is mandated, since CARB's formulation is more expensive to produce. Third and finally, California's oil industry mergers and acquisitions are regulated from an anti-monopoly perspective, with an eye to preventing too much of the production of local fuel to fall into the hands of any one player. This has limited the ability of some established veterans to expand further at some points.

Industry Evolution

The downstream oil industry in California during Phases II and III is a two-generation story[307]. Generation I, the ***veterans***, consists of a set of companies that existed and had large refinery holdings in California during Phase II, between 1973 and 2001. Chevron, ExxonMobil, Shell, Texaco, Arco, Ultramar, and Tosco had all entered the California market by the mid-1980s. These companies directly experienced the regulatory moves governing refinery process emissions and requiring reformulation of gasoline products to meet CARB gasoline standards during Phase II. By the end of Phase II, three of these companies remained: Chevron, Shell, and ExxonMobil. The other four had either been acquired or had become the less important partner in a merger (i.e. Chevron and Texaco, which briefly became ChevronTexaco but dropped the Texaco a few years later).

By and large, the veterans appear to be either in maintenance or wind-down mode during Phase III. Chevron has maintained its large holdings but is unable to expand, possibly due primarily to monopoly regulation (when it merged with Texaco, Texaco's refinery holdings were spun off to co-owner Shell as a stipulation to approval of the merger[308]). Shell and ExxonMobil have both reduced their refinery investments in California by selling refineries: ExxonMobil in 1998 and Shell in 2005 and 2007.

Veterans that experienced and survived Phase II are not active supporters of additional regulation and may even discretely oppose it in some contexts. But they have lived with CARB regulation for some time; they are not currently trying to expand significantly in California; and regulation has its benefits. CARB gasoline's special formulation is made largely at California refineries and may serve as a de facto market barrier to out-of-state competition (CARB standards are more stringent than national standards). CARB gasoline standards also appear to have driven some smaller competitors out of business in the past; five refineries closed and a sixth did not upgrade to CARB standards around the time that CARB I and II were introduced.[309] Indeed, in some cases

[307] Or more – at least one full generation of refiners precedes those I discuss here. But those generations predate the core of relevant emissions regulation and are since all defunct or broken up.

[308] "Shell Oil to Buy Texaco Assets."

[309] Taylor and Fischer, "A Review of West Coast Gasoline Pricing and the Impact of Regulations," 242.

companies came up with shadier ways to profit more directly from regulation, as in the case of Unocal's patent ambush.[310]

These veterans display regulation-tolerant behavior during Phase III. They preferred responses that broadly worked within the nascent framework of carbon regulation, acting to influence the design and implementation of specific regulations like the low carbon fuel standard during the design of AB32. They were either neutral on Prop. 23 (Chevron, ExxonMobil) or opposed (Shell). Direct public opposition was more narrowly targeted (at the low carbon fuel standard specifically), and seems to have been applied only as a second step, post-Proposition 23, when these companies saw a lessening of national incentives for biofuels development and felt that they could make a case that alternatives had been tried and were not yet satisfactory.[311] As a result, these companies tended not to play active, public roles in directly opposing the major new regulatory steps taken in Phase III. They were not typically regulation supporters; but they did stay fairly quiet about California regulation.

Meanwhile, Generation II, the ***newcomers***, is a set of companies that entered the California refining industry rapidly just as Phase III was beginning, largely through acquisitions of the losers of Generation I (Ultramar, Tosco, Texaco, and Arco), and via purchases of refinery assets sold off by the winners of Generation I (disinvestments by Exxon in 1999 and Shell in 2007 were bought up by Valero and Tesoro respectively). The key players in Generation II are Valero and Tesoro. BP and ConocoPhillips also enter around this time (or, in ConocoPhillips' case, re-enter), but not aggressively – see footnote for discussion.[312]

Both Valero and Tesoro were expanding aggressively in the California market (at least prior to the passage and successful defense of AB32). Between 2001 and 2013, Tesoro went from no California refining capacity to around 510,000 barrels per day – the second-largest single owner after Chevron. Valero entered California refining in 2000 and expanded to 216,000 barrels per day by 2002.[313] Meanwhile, Valero was also expanding

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[310] Hemphill, "Technology Standards Development, Patent Ambush, and US Antitrust Policy"; Unocal was eventually bought by Chevron; as a condition of approval to the merger, Chevron and Unocal were required to cease enforcement of these patents (Mullin, "FTC Approves Chevron's Acquisition of Unocal on Condition of Release of Patent Rights to CARB Reformulated Gasoline").

[311] Elgin and Waldman, "Oil Firms Break Promise on Biofuels as Chevron Defies California"; Elgin and Waldman, "Chevron Defies California on Carbon Emissions."

[312] BP enters by purchasing Arco (with one California refinery) in 2000 (Brooks, "BP Amoco Will Acquire Arco for $27 Billion."). ConocoPhillips enters by acquiring Tosco in 2001 (with two CA refinery facilities). But neither seems to have been very committed to the California market per se; in both cases the CA refineries acquired were merely a subset of an acquisition with multiple, geographically dispersed assets. Neither has made any other significant acquisitions in the California market since then. After holding it through most of Phase III, BP eventually sold its refinery in part to deal with fallout from the Deepwater Horizon Gulf oil spill in 2010. ConocoPhillips decided in 2011 to spin off its downstream operations, including refineries, to a new entity ("ConocoPhillips Pursuing Plan to Separate into Two Stand-Alone, Publicly Traded Companies."); this was actually something it had been considering doing since before the Tosco acquisition (Barrionuevo and Deogun, "Phillips Petroleum Will Acquire Tosco in $7.49 Billion Stock Deal."). In short, the newcomers seem to separate into two groups: those aggressively pursing California's market, and those not doing so. It is the first set that funded Prop. 23.

[313] Energy Almanac, "California Oil Refinery History."

its gasoline distribution network aggressively as of the mid-2000s; it had added 300 stations (about 1/3 of its total) between 2005 and 2007, giving it ownership of about 10% of California's total service stations – an "unusually speedy entry for a new brand."[314]

Valero and Tesoro responded to new emissions regulations by aggressively opposing them. The two companies were the largest single donors to the Yes on Proposition 23 campaign. Proposition 23's failure prompted Valero to strongly contemplate selling off its California holdings.[315] (It ultimately did not, because it found "little interest shown for refineries in [a] heavily-regulated market."[316])

Summary

Table 9 presents a summary of the key facts about several key players in California's oil industry.

In short, the different responses of the two groups appear well explained by two factors: apparent relative importance of the California market to their business plans, and level of existing investment in alternative technologies that could make money in a highly regulated environment. The key newcomers, Valero and Tesoro, are US domestic-focused companies (making California a relatively important market) and have little productive investment in low-carbon businesses.[317] They strongly supported 23. The key veterans, Chevron, ExxonMobil, and Shell, are more globally diversified and less tied to California; they have also put significantly more resources into the development of alternate or parallel lines of business that might profit in a highly regulated environment (such as energy efficiency services, low-carbon energy generation, advanced biofuels, and carbon capture and storage). In other words, they are comparatively regulation-adapted. These veterans largely remained neutral on 23. Shell, which appears to have the strongest portfolio of renewable and low-carbon businesses by 2010, opposed it.

[314] Douglass, "Valero Quietly Steps on Gas in State."

[315] Lefebvre, Dezember, and Fowler, "Valero Shopping Its Two California Refineries."

[316] Sider, "Valero Cancels Sale of California Refineries."

[317] Valero's ethanol branch is penalized by California's Low Carbon Fuel Standard, which uses a full life-cycle assessment to calculate carbon emissions and hence does not reward corn ethanol. It's hard not to imagine that this must have been frustrating to Valero. It made a major purchase in corn ethanol in early 2009. Given that, in the same annual report it announced the purchase in, it also expressed skepticism about the science of climate change and the necessity of low-carbon fuel regulations, one has the sense that this purchase may have been made as a sop to regulation and with the hope that corn ethanol would be a cheap and objectively profitable way out of a regulatory bind. Roughly a month later, California's regulatory decisions rendered corn ethanol holdings essentially irrelevant to the California market.

Table 9: Major Oil Companies' California Market Positions

	Company	Position on Prop. 23	Size Trend in CA Market	Focus of Business	Position in Green Businesses 2006	Position in Green Businesses 2010
CA Newcomers	Valero	Contributed in favor	↑	Domestic (US)	None found	Major corn ethanol holdings (as of 2009); small-scale investments in wind and other biofuels research.
	Tesoro	Contributed in favor	↑↑	Domestic (US)	None found	None found
	ConocoPhillips	Unclear/ Neutral	↑/–	Global	None found	Appears minor; some investments in renewable fuels, esp. diesel; and compressed-air energy storage
	BP	Neutral	–/↓	Global	In solar manufacturing business; has low-carbon power business (wind, solar, and others); newly created biofuels business	In solar business; building biofuels and wind businesses; researching CCS; planning to divest much of US refining assets
CA Veterans	Chevron	Neutral	–	Global	Biofuels business; energy efficiency svcs. & renewables installation; NiMH car battery technology; major geothermal projects (Indonesia)	Continued 2006 ventures; also installed several major pilot-scale solar PV facilities and bought a small-scale wind farm.
	ExxonMobil	Unclear/ Neutral	–/↓	Global	Partnerships in advanced engine and fuel systems; seed investment in environmental R&D; gave up to $100M to Stanford's Global Climate and Energy Project.	Research on carbon capture and storage; research in advanced biofuels and energy efficiency technologies.
	Shell	Opposed	–/↓	Global	Extremely varied. Sales, commercialization, and/or R&D in: biofuels, including advanced biofuels; CCS; gasification/syngas; hydrogen fuel/fuel cells; solar & offshore wind generation; renewable power nat'l gas extraction. Shell Trading is a "leader" in carbon trading.	Exited solar and wind in 2009; otherwise continued to pursue 2006 ventures. World's largest biofuels distributor; major sugar cane projects. Major demonstration projects in carbon capture and storage.

The erosion of opposition from potential active opponents (the veterans) is, I argue, a result of encounters with prior rounds of regulation – not only in California but also, since these are globally diversified companies, synergistically in Europe. Regulation of the oil and gasoline industry during Phase II did not for the most part transform oil and gasoline companies into *active* supporters of regulation. But it did create a set of regulatory veterans who had experience in handling regulation, had investments in some side businesses that had the potential to be profitable in an isolated, highly regulated market like California, and did not appear any longer to view the California market as a target for significant additional investment (beyond refinery upgrades as necessary). These

players largely refrained from opposing AB32 and supporting Proposition 23 directly. Aggressive newcomers who had not experienced much direct prior regulation had not yet adapted to regulation and were still pursing aggressively anti-regulation strategies, as well as still looking to expand in California. This left the newcomers, who were not perceived as locals, isolated and (in Phase III) helped to make the pro-Proposition 23 coalition critically weak. This creation of regulation-tolerant oil constituencies during Phase II is one part of the green spiral story in California.

The Broader Business and Manufacturing Industry – Mixed Responses

Like any state, California also plays host to a diversity of other industries. Oil, utilities, venture capital, and green industry (with high technology industry generally) are some of the power players in green politics both because they are important economic groups with strong voices, and because they are directly affected by green regulation. But California's economy includes a broad mix of other groups, and these other industries host some of the remaining pockets of direct resistance to regulation outside of fossil fuels. In general, contemporaries saw (non-oil) business as being split between Silicon Valley and the high tech/green industries on the one hand, and other business and manufacturing on the other hand. The LA Times reported along these lines, commenting on the split in the business community and stating that "manufacturers and other conventional business groups worry that the emissions law would drive up already high electricity rates in a weak economy"[318].

Pockets of Resistance

An examination of support for Proposition 23 shows that much of its support came from the fossil fuels industry, but there are several clusters of exceptions. One is industry actors related to the ***building industry***: representatives of plumbing and pipe-fitting; businesses providing services for planning, designing, and constructing projects; and lumber all gave funding to Yes on Proposition 23[319] (though generally in lower amounts than fossil fuels companies). The building industry continues to pop up in opposition to AB32 even now; the Pacific Legal Foundation, a majority of whose members seem to be connected to the building industry, real estate, and related law practice, is still working to oppose AB32 implementation[320]. Other industries that (at least in part) took similar positions include ***some manufacturing industries***, such as those represented by the California Manufacturers & Technology Association[321]; ***agribusiness and food processing*** (The Coalition of Labor, Agriculture, and Business contributed a supporting argument to the California Voter's Guide[322]); and ***transportation*** (such as CARGO-PAC, a California trucking industry PAC). Like the building industry, both of these last two contributed clusters of support to funding

[318] Lifsher, "Ballot Initiatives Divide a Usually United Business Front."

[319] Cal-Access, "Campaign Finance: Yes on 23, California Jobs Initiative, a Coalition of Taxpayers, Employers, Food Producers, Energy, Transportation and Forestry Companies."

[320] Taylor, "Salinas Growers Asked to Oppose AB 32."

[321] Rizo, "DiCaro: Shelving Calif. Greenhouse Law Will Save Jobs."

[322] "California Proposition 23, the Suspension of AB 32 (2010)."

Yes on Proposition 23[323]. These industries' arguments about AB32 focus on the costs that further emissions reduction and efficiency measures will impose on manufacturing and production in California, and blamed AB32 for a decline in manufacturing size and growth between 2001 and 2009[324].

Explaining Scattered Regulatory Opposition

One thing these industries have in common is that they are largely subject to regulation in two forms: on the one hand, they may be directly impacted by efficiency regulation, which often creates up-front adaptation costs. Or they may face rising input prices due to emissions regulation, either indirectly (i.e., through the effects of reformulation requirements on the cost of fuel, or the RPS on the cost of power) or directly (i.e., because they are impacted by the nascent cap and trade regime, which places an effective price on emissions). Meanwhile, the types of regulatory effects felt by these businesses are not ones that tend to grow a great deal of new business for these industries directly. In other words, efficiency regulation, carbon pricing, and RPS don't do much to create new constituencies among these sectors of the economy. In other words, these industries for the most part fall into the Management segment of the typology proposed in Chapter 4.

The building industry provides an example. A specific set of regulations targeted building efficiency during Phase II. Beginning in 1978, California established its Title 24 building standards; these are strengthened every three years and require buildings to meet energy demand efficiency standards[325]. Building standards create costs that are, at an economy-wide level, outweighed by long-term savings and other beneficial economic impacts such as increased employment. David Roland-Holst notes, "the kind of technology adoption needed for building standard conformity is unusually employment intensive, and promotes job creation among relatively high wage, diverse groups of semi-skilled and unskilled workers."[326] However, those savings and benefits are largely realized by building owners, consumers, and laborers - not the builders who bore the upfront costs of hiring workers and installing more expensive materials, or the developers and real estate agents that had to sell buildings at higher prices to recoup these up-front costs.

This is a classic case of government intervention to solve a market failure, capturing positive externalities by mandating behavior that is beneficial at the societal level but not directly beneficial to individual actors. And it is quite effective at that task. But what it does not do, for the most part, is change fundamental interests or create novel interests such that the regulated constituencies will shift to supporting further regulation.

There are exceptions. For instance, within the building industry there are groups that benefit from the increased work provided by green building and retrofitting, such as related labor groups. Those opposed to Prop. 23 (that is, pro-regulatory groups) included

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[323] Cal-Access, "Campaign Finance: Yes on 23, California Jobs Initiative, a Coalition of Taxpayers, Employers, Food Producers, Energy, Transportation and Forestry Companies."

[324] Rizo, "DiCaro: Shelving Calif. Greenhouse Law Will Save Jobs."

[325] Roland-Holst, *Energy Efficiency, Innovation, and Job Creation in California*, 18.

[326] Ibid., 21.

labor organizations like the Western States Council of Sheet Metal Workers (WSCSMW) and the California Conference of Carpenters (CCC). David Curtin of the CCC argued,

> California is the leader of renewable energy in America… Workers are being retrained to work on solar and wind projects, to build energy efficient buildings. If Prop 23 passes, this revolution will come to a halt. [327]

But for the most part, in these industries, efficiency and carbon pricing regulation does not lead directly to large-scale growth of new business, nor does it shift the business models of existing businesses such that they benefit from additional regulation. Rather, it leads to elevated input costs and additional one-time costs for upgrading or installing new equipment. Unsurprisingly, then, even California's history of efficiency and emissions control regulations has not done much to shift the interests of these industries over time.

I suggest that this pattern highlights a weakness of direct efficiency regulation in the context of policy feedback. Direct efficiency measures and indirect measures with similar effects, like weak carbon pricing incentives,[328] often have real economic payoffs. But they don't necessarily create or expand novel, coherent, regulation-supportive industries; or fundamentally restructure the incentives of the industry around direct capture of efficiency gains; or force existing industries to build new factories that require more regulation to increase demand. Moreover, efficiency gains are static; once captured, they are captured. A California homeowner may benefit from the fact that her home is more efficient than it would have been had regulation not existed during its building, but once her house is built, she does not benefit more from further regulation. Rather, additional regulation would likely just create additional up-front costs – probably higher ones, since the second round of efficiency gains tends to be more expensive. For all these reasons, direct efficiency regulation may not be very effective at creating or growing its own constituency.

CASE STUDY 2: DENMARK – A PARALLEL SUCCESS STORY

California is not an isolated case of local-level green spiral. Here I present the Danish case to provide a comparison of a similar process that similarly led to a "successful" outcome in the form of a comparatively stringent package of green regulation enacted at the local level. I draw the description and timeline presented here from the Danish case presented in Zysman and Huberty,[329] by Jakob Riiskjaer Nygård,[330] with a few points added.

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[327] Roosevelt, "Battle over Proposition 23 Gets Airborne."

[328] "Weak" is a key qualifier here. In principle strong carbon pricing mechanisms might well cause deeper industry reinvestment and reconfiguration, which would change interests in the long term. However, political will for strong carbon pricing is rarely available until an economy is already reconfigured. Weak carbon pricing tends to focus effort on near-term low-hanging fruit, like efficiency gains that can be captured by small or moderate investments in, e.g., process improvements.

[329] *Can Green Sustain Growth? From the Religion to the Reality of Sustainable Prosperity*.

[330] "Denmark: A Classic Case of a Green Spiral."

Like California, the Danish case proceeds in a series of semi-distinct regulatory rounds. In the **first phase**,[331] beginning in 1973, Denmark responded to the OPEC oil crisis with a multi-pronged regulatory response. Denmark ramped up oil and gas exploration in the North Sea via the state-owned company Danish Natural Gas (which became DONG). But in parallel, Denmark largely cut oil out of its domestic energy mix, shifting initially to coal for much of its energy needs. Finally, it began pushing alternative energy: nuclear and wind were both considered, but civil society resisted nuclear, so much of Denmark's efforts here went into wind, with regulatory moves such as investment tax credits, a 30% investment subsidy for new wind energy installations, household tax exemptions, and a feed-in tariff (FIT), and others[332]. Ironically, Denmark also benefitted from incentives introduced by California in the mid-1980s, which drove export growth; this is suggestive of the way that green spirals in one nation can influence those in another.[333]

This phase had several important effects. First, the regulatory incentives that drove local ownership of small wind installations created a strong grass-roots constituency for policies favoring wind generation. The Danish Windmill Owners Association was created in 1978; 120,000 Danes were involved in local ownership of wind turbines by the early 1990s.[334] Second, wind-friendly regulation (in combination with the serendipitous effects of California policy moves) also supported the creation and growth of major wind technology companies, most importantly Vestas, which ultimately became one of the world's largest wind turbine manufacturers. Thirdly, infrastructure investment in district heating grids changed the structure of the Danish heating and electricity industry, putting in place the necessary infrastructure for combined heat and power (CHP) plants, which made energy generation more efficient and, later, allowed for the integration of biomass. Finally, I speculate: since Denmark does not itself produce coal, the shift toward coal may have led to an "off-shoring" of fossil fuel interests and a reduction in the set of *local* interests with reasons to directly oppose local green policy.

In the **second phase**[335] of energy policy in Denmark, from 1993 to 2001, Denmark's policy became overtly environmentalist. In the previous phase, green policy was a side effect of the desire to increase energy independence; in this second phase, the goals were more explicitly green. By 1996, Denmark had created many initiatives designed for CO2 reduction, and an annual target of 1% additional renewable energy – a policy that rewarded and continued to drive ownership and investment in wind. In short, during this phase, Denmark's earlier movement toward green energy economic interests paid off in a policy program that sought to support further growth for those constituencies.

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[331] Ibid., 89–93.

[332] Mendonça, Lacey, and Hvelplund, "Stability, Participation and Transparency in Renewable Energy Policy: Lessons from Denmark and the United States"; Nygård, "Denmark: A Classic Case of a Green Spiral," 90–92.

[333] Karnøe and Garud, "Path Creation: Co-Creation of Heterogeneous Resources in the Emergence of the Danish Wind Turbine Cluster," 744–745; Mendonça, Lacey, and Hvelplund, "Stability, Participation and Transparency in Renewable Energy Policy: Lessons from Denmark and the United States," 385.

[334] Mendonça, Lacey, and Hvelplund, "Stability, Participation and Transparency in Renewable Energy Policy: Lessons from Denmark and the United States," 385.

[335] Nygård, "Denmark: A Classic Case of a Green Spiral," 93–95.

Like California, Denmark has a deregulatory interlude. In this **third phase**,[336] from 2001 to 2006, right-wing policymakers under Anders Fogh Rasmussen came to power and initiated a program of deregulation and privatization. Although this government's focus was on other issues, part of its program did include cuts to funding for environmental and renewable energy programs. But these cuts were not popular (50 percent of Danes were against them, and only 35 for them[337]). Essentially they were a challenge to green policy that was ultimately defeated.

In the **final fourth phase**,[338] from 2006 to the present, the Rasmussen government tacked back toward green policy (and the center-left eventually regained power in 2011). During this phase, environmental policy was renewed. Currently, Denmark is targeting 35% renewables share by 2020 using incentives, subsidies, and mandates for expansion of wind, biomass, and biogas. It is pursuing policies like the mandatory phase-out of oil furnaces, and further steps to adapt the electrical grid for renewables integration, like the installation of large heat pumps. The transportation infrastructure is also being restructured. These steps are further reducing the sunk-cost infrastructure investment in fossil fuels and removing obstacles to renewables expansion.

These policy moves are leading to further regulation-adaptive co-evolution on the part of industry. DONG Energy is an exemplar. In recent years, DONG has chosen to withdraw visibly from investment in fossil fuels projects like coal plant construction – even ones in other European countries where contracts have already been signed and partial investment had already occurred. A DONG official commented that these were strategic choices; DONG believes at this point that coal-powered projects are bad investment bets in the long term, not necessarily profitable over their lifetime. Better to pull investment and direct it to projects expected to be long-term profitable.[339]

In short, for Danish industry, the paradigm has shifted. Denmark's history of policy-industry feedback – no doubt combined with relatively pro-regulation conditions in Europe as a whole and in export markets like California – has led to an industry outlook where interests are seen as aligned with carbon emissions regulation. This stems from past policy; it supports current policy; and it makes aggressive future policy plans politically viable.

JAPAN – A FAILED SPIRAL

Summary

A brief study of the Japanese case provides a useful counterpoint to the California and Denmark "success stories". Japan is a case of policy industry feedback spiral failure. Here, I briefly review its case history, and comment on what may have led to spiral failure in this case. This description and timeline is summarized from the work of Brian Woodall

[336] Ibid., 95–97.
[337] Ibid., 98.
[338] Ibid., 97–100.
[339] Ibid., 99–100.

on this case, as presented in *Can Green Sustain Growth?*,[340] with my own commentary added.

As with many of these cases, Japan can be portrayed as a series of phases. In the **first phase**,[341] prior to significant regulation, Japan was a swiftly growing economy, aided by plentiful access to low-cost power from coal- and oil-powered plants. Toward the end of the 1960s, Japan's rapid industrial growth led to a set of environmental and health crises created by industrial byproducts.

In the **second phase,**[342] running roughly from 1970 to 1990, Japan responded both to local pollution crises and to the oil crises of the 1970s by initiating pollution control and energy efficiency policy. The Basic Law for Environmental Pollution Control was enacted in 1967; an Environment Agency created in 1971; the Emergency Petroleum Countermeasures Policy was adopted in 1973; the Japan Energy Conservation Center was established in 1978; and in 1979 an Energy Conservation Act was passed. Policies including tax incentives, subsidies, preferential loans, grants, and mandatory appointments to encourage energy conservation were directed at the industrial and other sectors. Like the California efficiency mandates, the Energy Conservation Act established efficiency and energy usage criteria in various sectors – such as industry, buildings, equipment, and transportation.

Another branch of policy during this period focused on changing Japan's energy mix. Some relatively small incentives and funds for the development of renewable energy technologies, particularly solar and geothermal, were provided. But much larger, and much more successful, was a nuclear energy generation program, which provided subsidies to nuclear plant host towns. Host towns received funding, jobs, economic activity in the form of major construction, and products of funding, such as infrastructure and municipal projects.

This phase had several effects on industry, both energy and manufacturing. First, Japan became extremely good at both energy efficiency and energy efficiency technology and products. Japanese companies became "world leaders in the production of pollution control devices." Efficiency programs were effective; Japan's industrial sector's consumption of energy was reduced and controlled. Second, Japan became much more nuclear-focused. Nuclear provided 1% of total energy in 1973; 5% by 1980; and 10% by 1986. Renewable energy did not grow particularly strongly during this period; the percent of renewables in Japan's energy supply did not exceed 1% until 1990.[343]

During the **third phase**[344] of Japan's story, the 1990-2000 "lost decade," not much of interest happened. There were some additional efforts in renewable energy. Japan made some big promises during early climate negotiations, particularly in 1997 when it took on one of the stronger emissions reduction targets in the Kyoto Protocol. But did not really substantially alter its trajectory. Nuclear energy grew from 10% of total supply to 13%.

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[340] Woodall, "Japan: Paragon of Energy Efficiency, Green Growth Laggard."

[341] Ibid., 152–154.

[342] Ibid., 154–157.

[343] Ibid., 155–159.

[344] Ibid., 157–159.

During the **fourth phase**,[345] from 2001 to 2010, Japan underwent a deregulation of energy markets and made a host of various energy-related policy moves. A new Fundamental Law on Energy Policy Measures was passed, and Japan made a series of Basic Energy Plans (BEPs); these plans contained targets for energy self-sufficiency, emissions reductions, and growth in "energy-related products and systems." Some specific measures were taken, such as a renewable portfolio standard in 2002 (which was criticized for being low); the establishment of a solar-only feed-in tariff for households and businesses; and efficiency programs such as the "Cool Biz" campaign, which pushed energy users to raise their AC temperature settings to reduce AC energy use. The BEPs consistently pushed nuclear generation expansion and efficiency. Along with the Cool Biz program, the Top Runner Program was established for vehicle fuel efficiency and appliance energy efficiency, and the Eco-Point system was created to reward consumers for purchasing designated high-efficiency appliances.

The effects of these programs tended to extend general trends rather than set a new course. Renewables and hydroelectric power together were holding around 6%, with remaining energy generation from fossil fuel and nuclear. Japan continued to grow in nuclear and had a massive ramp-up planned: 14 new plants and the capacity to supply half of Japan's electrical needs by 2030. Japan remained strong in efficiency. It had some early leadership in the manufacturing of solar PV modules, but subsidies for these modules were cut in 2005 while Japan was facing increasing competition, particularly from China. Japan never regained leadership, in spite of a return of subsidies in 2007. Japan has developed and retained leadership in one green industry – hybrids and plug-in electric vehicles.

During this period, a DPJ government made aggressive pledges for GHG emissions, but was immediately undermined by protests from government bureaucrats and business. By December 2010, Japan refused to enter a follow-up emissions reduction target under the Kyoto Protocol unless India and China also pledged similar cuts, which was politically non-viable.

Japan's final, **fifth phase**[346] began in 2011 with the earthquake, tsunami, and Fukushima nuclear disaster. This shock has led to a major shift away from nuclear, canceling the planned ramp-up and stopping other plants. To meet short-term needs in the face of nuclear plant closures, Japan doubled down on efficiency measures, with a variety of mandatory cuts in electricity for large users and turbocharged efficiency programs like the "Super Cool Biz" campaign. A new renewable energy bill was approved with stronger feed-in tariffs that cover not only solar but other renewables. It is difficult to tell whether these recent moves will result in a different long-term trajectory for Japan's industry interests.

Commentary

Japan is a useful case because its origins look a great deal like California: it responded to pollution and oil crises with a variety of policies designed to cut oil use and

[345] Ibid., 159–163.

[346] Ibid., 163–168.

increase efficiency. But the outcome in Japan has been different. Japan has not seen the kind of policy-industry feedback loop we see in California. If anything, Japan reached its (relatively low) peak of political viability for low-carbon policy somewhere in the 1990s and dropped off subsequently (at least prior to Fukushima). This is not to say policy had no long-term effect in Japan. But those long-term effects seem largely confined to two areas: efficiency and nuclear power. In the first, Japan remains a leader. In the second, subsequent external shocks have called into question Japan's trajectory. Neither area seems to have created greater industry support for additional low-carbon policy generally. I pause here to examine the implications of this contrasting case more closely. Several possible explanations for Japan's different outcome present themselves:

Problems of nuclear power in the green spiral context: The most obvious difference between Japan on the one hand and California and Denmark on the other is that Japan pursued nuclear power while both California and Denmark did not. There are at least two reasons why nuclear might be problematic in the context of a nascent green spiral. First, nuclear may be directly competitive with the growth of other green interests; each kilowatt generated by a solar array or wind turbine is a kilowatt not generated by nuclear. And since green energy is less fully developed than nuclear, it requires a different regulatory framework to support it. An ideological divide may exacerbate this problem; it is often the case that citizen groups most vocally supportive of green energy view nuclear as problematic and oppose it. Hence, although nuclear power *is* low carbon, nuclear may have good strategic reasons to oppose – or at least not support – renewable energy policy. This dynamic could keep it out of a pro-regulation coalition.

Second, the international context limits the ultimate growth prospects of the nuclear industry in the export arena. Most countries that are currently active in green policy have made de facto decisions not to pursue nuclear as an option, as it is seen as low-carbon but not "green." In other words, nuclear as an industry has little in the way of export markets; and those export markets, such as they are, have little or nothing to do with green policy. This provides another contextual factor that disconnects the nuclear industry from pursuit and support of green policy.

Ineffectiveness of direct efficiency measures for generating fundamental interest shifts: One difference between California and Japan is that, while both instituted efficiency measures, it is not clear that Japan has any equivalent of the restructuring programs that turned California's utilities into novel advocates for green policy in later regulatory rounds. Japan seems mainly focused on direct efficiency regulatory programs. I suggested in my California analysis that although such programs may quite effectively increase efficiency, they do not seem to have been as effective at changing the interests of constituencies for whom they were the primary interaction with green policy. The Japan case is consonant with this reading. This suggests the distinction points made above about Management industries vs. Winner/Substitutable industries.

These points merit a great deal more investigation and are difficult to prove in the scope of this project. But it is plausible that the two green/low-carbon policy areas Japan chose to focus on are two areas that are particularly ill-suited to kicking off and supporting a green spiral dynamic.

China – Green Spiral, Brown Spiral

Having looked at three developed, fully industrialized countries, it is useful to look briefly at China. The Chinese case is both inherently important, since China is now the biggest single-country carbon emitter, and another useful contrast, since China is a rapidly developing rather than fully developed country. My description of this case draws on the work of Crystal Chang and Jany Gao,[347] along with my own thinking and commentary.

Political Background

Unlike the three cases above, China is not a democracy, and aggregation of interests does not function in the same way. But the Chinese government does face pressure to maintain legitimacy in order to avoid serious domestic unrest. As Chang and Gao note, legitimacy stems from the ability to provide economic growth and increase incomes over time.[348] This means China has several imperatives. First and foremost, it needs to maintain growth so that individual prosperity continues to rise. Secondarily, to maintain economic growth, it has to keep feeding increasing amounts of electrical power into the system at reasonable prices. Finally, it needs to do all this without allowing already-serious pollution to become unlivable.

Thus, interest groups like industries matter to the extent that they help or hinder Chinese leaders in meeting these goals. For instance, a rapidly growing industry that avoids high emissions and/or displays high energy efficiency will receive support from the Chinese government because it helps achieve economic growth goals without making it difficult to achieve secondary environmental or electrical power goals. In this context, I argue that green spiral-like dynamics can still work: promising green industries will receive some support and attention from the government; which will help them to grow; which will lead to more attention, more integration into China's strategic goals, and more support; and so on.

Green Spiral

Viewed narrowly, I would argue that a green spiral in green industry seems to be precisely what is happening to China. The Chinese government's five year plans (FYP) have for some time targeted green industry such as solar and wind as strategic industries that are earmarked for growth and support. China engages in a raft of policy measures designed to support green industry and efficiency; these include mandatory purchasing, incentives, subsidies, tax breaks, favorable loans, efficiency standards, labeling and advertising campaigns, and mandatory closures of inefficient or energy-intensive generating and manufacturing facilities.[349] China's efficiency and growth goals have both been quite successful. Its energy intensity dropped 19.1% from 2005 to 2010.[350] In

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[347] "China: Green Industry Growth in a Brown Economy."

[348] Ibid., 189.

[349] Ibid., 196–198.

[350] (Ibid., 197.) How successful is this? It is surprisingly hard to say. First, China's data is not transparent and differs from, for instance, the US Energy Information Agency's (EIA's) data. In addition, not many economies have undergone comparably fast growth across similar levels of GDP per capita during the same time period. The closest comparisons are mostly ex-Soviet Eastern European countries, which may not be fair

absolute terms, installed renewable capacity was second only to the US as of 2010. China was the largest single exporter of wind turbines in 2009 and of solar panels in 2010[351].

Brown Spiral

Viewed more broadly, a structural shift *away* from brown interests is not occurring in China. As Chang and Gao observe, "The economic potential of green industries alone is not enough to sustain the Party's side of the bargain" that maintains political legitimacy.[352] China hosts a fairly self-contained export-oriented green spiral, but is at the same time undergoing rapid parallel growth in brown industry. China is building solar and wind as fast as it can; but it is doing the same for coal and gas; and the ratio is changing only marginally. The government is still targeting only 15% non-fossil fuels in primary energy consumption by 2020;[353] and even that modest goal remains to be achieved. China's economic base remains skewed toward energy-intensive manufacturing, and that is unlikely to change soon.

Commentary

In a sense, China may be one of the very most successful spiral cases; China is certainly experiencing "green growth" in the sense that green industry is a booming part of its economy, is targeted strategically for future growth, and seems to be becoming increasingly important to the Chinese government. The difference is that in *developed* countries where the rate of growth is slower and energy grids are largely built out, hosting a growing green industry sector often means changing what we are doing, replacing one type of energy with another. In *developing* countries, more green doesn't mean less brown; the two can grow in parallel.

In an international context, China could end up being the inverse of some of the cases described above. In developed countries, local green spiral stories may result in local emissions reductions before the world is ready for strong international deals. In contrast, it is possible China might eventually be prepared to sign an international deal – which would grow markets for its green exports – before it can practically reduce emissions at home. Still, a situation in which China is growing green industry rapidly, looking for expanding export markets, and lowering energy intensity at home is a good start.

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comparisons (they are comparatively sophisticated economies that began with artificially depressed GDPs and a legacy of inefficient Soviet-era infrastructure to remove). South Korea's growth across a similar span of GDP per capita (during the 1980s) may be the best comparison; during these equivalent periods, EIA energy intensity data has South Korea's energy intensity dropping 9.3%, while China's drops 12.7%. Some anecdotal data – such as the fact that China's efficiency measures bit hard enough that manufacturers were sometimes forced to drop off the grid and run operations off diesel generators to get around regulations (Ibid., 194.) – also suggest that efficiency measures were pushing the edge of the economy's ability to adapt rapidly.

[351] Chang and Gao, "China: Green Industry Growth in a Brown Economy," 198.

[352] Ibid., 189.

[353] Ibid., 198.

Discussion and Implications

These four cases allow us to draw some further conclusions about green spiral dynamics in the context of climate change.

Most importantly, the climate change issue area is not inherently inimical to green spiral dynamics. And the fact that they can occur in isolated cases in climate change not only tells us something about climate change as an issue area; it also tells us something about green spirals and the potential for unilateral green policy. Green spirals happen locally even when they don't happen globally, because green spiral dynamics can create contexts that allow industries that benefit from green regulation to *profit* locally. This means that pursuing green policy can become rational for local actors even when there is a lack of green policy at the global level and hence theory would suggest that green policy is not locally rational.

Nonetheless, it is true that where ozone was easy, climate is hard. In climate change where many interests are implicated, green spirals probably are more difficult to achieve than they are in more bounded issue areas like ozone and CFC production. Particularly in larger economies, the process involves mobilizing many more industries before a strong feedback dynamic is established, and that can take time. Both California and Denmark are stories that take decades.

On the other hand, these local stories strongly suggest that not every industry has to be fully converted. In many cases it may be sufficient merely to split up opposition and create a subset of powerful, vocal industry supporters. Reference to the typology introduced in Chapter 4 is useful here: in the success cases, policy-industry feedback tended to shrink, neutralize, offshore, and isolate Loser industries (like oil); grow Winner industries (like renewable energy equipment manufacturers); and convert some Substitutable industries (like power generation). In aggregate, this led to situations in which substantial portions of industry were willing to join pro-regulation coalitions, and fewer industries were interested actively in opposing coalitions.

A point that emerges both from these cases and the ozone case is that green spirals historically have not been intentional processes imagined by policymakers. Rather, they have often emerged organically from earlier rounds of regulation that addressed related but different problems. Such organic emergence is not foreordained, as the Japan case suggests; it is more of a lucky happenstance that depends on which of a variety of potential responses policymakers choose.

The analysis of these local cases also extends a theme I discussed at the end of Chapter 4: that not every "green" policy instrument is equally productive of green spirals. If policymakers seek to encourage green spiral dynamics in the future, they should consider not only the effectiveness of particular policy measures at reducing emissions per se, but also their particular effectiveness at growing pro-regulatory constituencies, converting Substitutable constituencies, and shrinking anti-regulatory constituencies over time. In a big, multi-headed problem like climate change, sets of measures that accomplish specific goals well but fail to build momentum for the next round of regulation may not be very effective at all in the long term. In Chapter 4 I focused on carbon pricing; this chapter suggests that from the perspective of shifting fundamental interest configurations, there are similar reasons to be skeptical of nuclear; and of efficiency

measures, *unless* they are structured so that they create specific "efficiency constituencies". More generally, I posit that it is likely that measures aimed largely at Management industries will be vulnerable to this issue.

However, contrary to general assumptions of environmental and economic literature, I think there is some reason to believe that outsourcing and offshoring may be helpful in some contexts. Much of the literature on international environmental policy-making has treated leakage and outsourcing of emissions-intensive industry both as a danger to the effectiveness of emissions reduction *and* an obstacle to the political viability of cooperation. But there are two contexts in which these cases suggest it might be productive, at least in moderation. First, offshoring of opposing interests may create greater political viability for local green spirals. In a case like climate change, where many industries are affected and there is pervasive opposition to green policy, this kind of hiving off of green and brown interests may actually be useful if it creates incubators where green industry interests can gain strength and from which they can ultimately expand. Second, local green spirals and resulting green product demand can drive green industry growth outside the local area.[354] That can catalyze or support green spirals elsewhere. We see this in multiple places in these cases. California's early policy moves helped drive the creation of green industry interests in Denmark, without undermining California's green spiral. Meanwhile, China's green industry has benefited enormously from the markets created by pockets of green policy in the US and Europe; if China did not have these markets to pursue, it is unclear that it would have prioritized green industry. That growth in China offers the best prospect of an international deal that we currently have; we are reaching the point where regulation would need to broaden and spread in order to keep the market for Chinese green energy products growing.[355]

On that note, these cases suggest that what we can expect from green spiral dynamics in developing countries – even when they are occurring strongly – is different from what we can expect from the same dynamics in a developed country. In developed countries, a strong green spiral almost necessarily implies a shift in energy base. The rapid economic expansion that developing countries undergo during successful development creates a different set of constraints. Like China, developing countries may actually see thriving local green spirals that develop in parallel to strong "brown spirals" of carbon-fueled industry growth, as countries build out both types of infrastructure. This suggests that when negotiating with developing countries, deals are going to have to focus more on encouraging the green spiral dynamic and creating markets for green industry, and less on shrinking brown interests, at least at first. It remains to be seen whether green spirals in developing countries may lead to moderation of negotiating positions, if such moderation can help create and capture expanding export markets.

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[354] This is similar but not identical to David Vogel's writing on the California Effect, by which trade may spread environmental and safety regulations (Vogel, *Trading up: Consumer and Environmental Regulation in a Global Economy*.). See a discussion of Vogel's argument in my conclusion (Chapter 6).

[355] Brewster (Brewster, "Stepping Stone or Stumbling Block: Incrementalism and National Climate Change Legislation.") suggests the possibility of some similar mechanisms in her theoretical analysis of the potential effects of proposed US climate legislation.

Conclusion: Local Stories and International Negotiations

What do local stories like these tell us about the status of climate change and climate change negotiations as a whole? The current state of negotiations seems fairly discouraging, but local stories do offer glimmers of light. Global deals have not yet achieved sufficient political viability to create momentum on regulation. But prior rounds of effort have created the technological solutions needed to solve the problem – a necessary but not sufficient step. And local stories are developing in ways that could be transplanted to other countries via international fora, just as the local story of the CFC producer industry in the US spilled over in the international arena in 1986 and 1987, creating the first major industry voice for change there. In my concluding chapter, I sum up and discuss the implications of the green spiral mechanism for policy and policymakers; for future negotiations; and for future research.

CHAPTER 6: CONCLUSION

SUMMING UP: THE GREEN SPIRAL MECHANISM

I have argued in this dissertation that a detailed examination of the evidence in two cases – the ozone and climate change negotiations – supports the importance of a mechanism previously not utilized in explaining in multi-round environmental negotiations. This mechanism, a process of policy-industry feedback that I refer to as the green spiral, provides a coherent explanation for the variation in outcomes we see at both the international and national levels. This process begins with initial policy moves, such as treaty outcomes. These initial moves lead, through processes I have traced closely through these cases, to reconfiguration of the material interests of relevant industries. And these reconfigurations of interest in turn reconfigure the coalitions of interest groups that determine what negotiating positions or policies are politically viable in a given round of negotiation or policymaking. As a result, this process can lead to the expansion of the politically viable space for regulation from round to round.

From my examination of these cases, I have also suggested a refinement to this mechanism: a typology that categorizes industry into four segments for the purposes of many environmental negotiations. These segments – Winner, Loser, Substitutable, and Management – help clarify the part of the green spiral mechanism that deals specifically with the evolution or reconfiguration of material industry interests in the contexts of cooperation around control of an undesirable externality such as pollutant emissions. The typology provides a framework for understanding specifically how policy moves affect particular industries, based on their place in the typology; why, as a result of their place in the typology, different industries respond in different ways; why some are more likely than others to undergo shifts in material interests; and which types of industry are most vulnerable to policy manipulation. The distribution of issue-relevant industries across the four categories, I argue, is a structural feature of an issue area that partially determines how easily a green spiral will occur in that issue area. Green spirals will be easiest to start and successful outcomes will be easiest to achieve when the following are true:

1) Loser industries are disorganized or politically easy to isolate and shrink.
2) Substitutable industries are large relative to Loser and Management categories, and comparatively easy to shift (for instance, substitutes are already well-developed).
3) Winner industries are well-organized and easy to grow.
4) Management industries face relatively low costs of adaptation and/or are relatively small, weak, or disorganized.

Of course, it is also helpful if Winner industries are already large, well-organized, and powerful, and Loser industries are already small and weak. However, in that case we do not face a green spiral situation – there we would expect an easy one-round negotiation since the political will should already exist for a full solution.

Theoretical Advantages

The green spiral mechanism as an explanatory factor has a number of advantages relative to the existing body of theory concerning international treaty making.

First, as I have argued throughout, unlike the existing body of theory, the green spiral mechanism provides a plausible comprehensive explanation for the disparate set of outcomes we see across these two cases. The presence or absence of a green spiral provides an coherent political explanation for why ozone negotiations succeeded in ratcheting up increasingly stringent regulation across rounds of negotiation; why international climate change negotiations have (thus far) failed to ratchet up increasingly stringent regulation across rounds; and why it has nevertheless been possible for increasingly stringent rounds of carbon emissions regulation to occur at the local level in some specific countries and states. Other sets of theories can explain some of these outcomes but run aground on others. By contrast, policy-industry feedback provides a "unified theory". Fundamentally, this is because it provides something the other theories of treaty making, in aggregate, do not provide: an explanation of the formation of national negotiating positions (as aggregates of national interests) that can explain not only existing positions but also how and why those positions can change over time in systematically positive ways conducive to treaty success.

Second, the green spiral mechanism helps illuminate other issues characterized by existing literature. One of these is the question of momentum and the "ratchet effect." There is a subtle underlying assumption to the multi-round process, which is that more may be achievable in round two than was achievable in round one, and so on. In other words, that there is some reason to expect that each round may be able to ratchet up the gains made in prior rounds. This was seen to occur in the ozone negotiations, and the design of climate negotiations – the use of commitment periods with the assumption that each new period would yield a more stringent set of emissions reduction targets – was implicitly predicated on the idea that it could occur again.

But it is not immediately clear why we should expect this dynamic. Why should round two of a multi-round negotiation yield more than round one? Existing literature does not have a wealth of explanations for why we might expect to see such a ratchet effect. The most direct explanation proposed is the set of knowledge-based explanations. These explanations posit that gains grow in each round because our understanding of the scope, consequences, and appropriate solutions to a problem grow, while technological advances bring costs of a solution down – collectively raising willingness to cooperate to solve the problem. We might also posit a combination of diplomatic entrepreneurship and lock-in – if treaties lock in existing gains such that they are difficult to walk back, and diplomatic entrepreneurs are occasionally able to find or manufacture opportunities to expand cooperation in a given negotiation due to random shifts and "noise," then cooperation might expand over time purely because expansion is possible but contraction is not – a literal ratchet.

Policy-industry feedback processes offer a more systematic explanation. If gains in a given round actually lead to shifts in material interests that make gains in the next round easier to achieve, then a ratchet effect is natural. It is easy to see how such a mechanism would produce cooperative "momentum". The presence or absence of such a mechanism

would also explain why some treaty making processes show ratchet effects while others do not, even when characterized by expanding knowledge and increasing certainty among experts, and advancing innovation in technology (as in climate).

Another issue raised by previous literature is that of the possible epiphenomenality of treaty making processes. Some scholars have questioned whether treaty making is in fact a fundamental driver of gains in cooperation, or simply an epiphenomenal result of other forces. Murdoch and Sandler,[356] for instance, contend that many CFC emissions reduction measures preceded the Montreal Protocol and that the negotiations merely codified reductions that the producers were, in fact, prepared to enact voluntarily in response to scientific evidence of ozone depletion.

The presence of a policy-industry feedback mechanism helps us understand this dynamic. At first view, individual rounds of ozone negotiation often appear epiphenomenal, because they reflect industry interests *at that point*. But the puzzle is in explaining why the interests allowing a particular outcome in a given round *change between rounds*. The policy-industry feedback mechanism suggests that although individual rounds of negotiation may in a sense be epiphenomenal at the point they occur, the process of treaty making – and feedback between treaty-based regulation and industry – is not. In particular, treaty making processes may allow leaders (countries whose industries have already begun to reconfigure and change interests) to provide stimuli that lead to reconfiguration in laggards (countries whose industries have responded more weakly). This may in fact be one of the most important potential functions of an environmental treaty.

The Relationship of the Green Spiral to Existing Treaty Making Theory

I argue in this project that policy-industry feedback is an important and under-recognized mechanism in environmental treaty making. It provides a missing link, without which existing explanations cannot fully explain the success or failure of environmental treaty making enterprises. But I am not arguing that it stands alone as a unitary explanation for negotiation behavior. Nor am I arguing that competing explanations have no value.

For one thing, policy-industry feedback assumes the existence of at least some motivated policy entrepreneurs at some point. Policy-industry feedback can explain why the success of policy entrepreneurs can expand over time across rounds – because the structural environment in which they operate is changed by initial policy moves. It can provide an explanation for why leader nations emerge at the international level to push for regulatory agreements – in at least some cases, this is due to policy-industry feedback processes at the domestic level. But it cannot (or cannot entirely) explain why individual policy entrepreneurs exist in the first place, why citizen advocacy groups form initially, why certain environmental threats are prioritized as important, how and why some issues become salient to individuals or advocacy groups at a particular time, and so on. These dynamics would appear to be better explained by explanations such at the knowledge

[356] "The Voluntary Provision of a Pure Public Good: The Case of Reduced CFC Emissions and the Montreal Protocol."

spread and epistemic communities literatures, or by other literatures that focus on the spread of norms and ideas, or on individual decision-making.

Thus, I am not arguing that existing lines of literature, like the epistemic communities literature or other structural and strategic explanations, are not useful. What the green spiral mechanism does is provide a necessary connective tissue between factors such as the mobilization of policy entrepreneurs and the existence of structural characteristics, and outcomes such as treaty success and failure. In particular, the mechanism helps explain why entrepreneurs, strategies, and innovation sometimes connect with positive outcomes and sometimes do not; and why structural features alone may not be entirely determinative.

In short, although for clarity's sake I have presented the green spiral as a separate mechanism, it is more likely in reality to be found interwoven with other mechanisms other scholars have characterized. In this sense, ozone is likely an unusually clear case. Because it was a fairly discrete set of industries and control measures had relatively clearly delimited impacts on the economy, the coevolutionary moves between policy and industry were, I suspect, particularly clear. An observer can trace a relatively distinct set of staggered shifts in both areas. But this analysis provides proof-of-concept for an underlying mechanism that can generalize, if perhaps more messily, to other cases.

Applying an Understanding of Policy-Industry Feedback in Current Negotiations

Viewed in the context of the green spiral, it becomes clear that the climate negotiations were not designed in a way that maximizes the likelihood that early rounds would tip off substantial policy-industry feedback.

An understanding of the green spiral mechanism suggests that policymakers and policy entrepreneurs should understand their issue area through the lens of policy-industry feedback and push for measures best suited to it. In climate, that means understanding not only that the size and complexity of the issue area is an obstacle, but also that the structure of the economy acts as a barrier that must be overcome. In this issue area, several pre-existing highly salient and politically powerful economic constituencies fall into the Loser or Management categories as opposed to the Substitutable or Winner categories. As a consequence, strong stimuli will be politically difficult to apply in early rounds, and weak economy-wide policy stimuli are unlikely to produce the kind of industry evolution between rounds that results in the speediest, most effective industry interest reconfiguration.

Thus, to be most effective, early-round policy stimuli should be targeted rather than generalized. Policy leaders should push for measures that make the best use of limited political will. These include a) targeted regulation, of limited scope, that has the greatest leverage to shift investment in Substitutable industries; b) subsidies that build the size of Winner industries over time; and c) innovation that provides novel solutions to Substitutable and Winner industries. Although I have focused on industry evolution specifically, it is worth noting that non-industry economic constituencies can also be relevant, such as citizen owners of distributed generation. An example is in Denmark, where a phase of widespread individual ownership of small-scale wind installations

helped create political will for policies that favored wind.[357] Similar dynamics appear to have occurred in some US states, such as Colorado[358] and Minnesota[359]. In democracies, the growth of such constituencies is supportive to green policy like the creation of feed-in tariffs and some forms of renewable portfolio standards. They can be targeted via executive policy like subsidies for small-scale wind installations or roof-top solar panels.

Non-governmental policy entrepreneurs should focus on contributions such as increasing the political power of Winner and converted Substitutable industries by making sure they are well-organized and find common cause; and to try to cut out and push ahead the leading adapters in the Substitutable, Management, and Loser industries. Examples of this type of competitive early adapter include DuPont in the ozone issue area; PSI Energy/Cinergy/Duke Energy under Jim Rogers in power plant emissions regulation;[360] and potentially Shell and/or BP in fossil fuels and carbon emissions. Even in Loser and Management industries, some companies may view themselves as most likely to be competitive in the near term if emissions restrictions are imposed. If the timeline of adaptation is long enough, it may allow a substantial period in which the ability to better weather regulation allows leaders to gain market share from peers. In such cases, the ability to gain market share in the near term may balance out fears of lost business in the long term, even in Loser industries, especially if they are investigating complementary technologies (such as Shell's investment in carbon capture and storage). These leading adapters can provide points of cleavage in industry that can be exploited by private policy entrepreneurs that want to show that industry is not united against environmental measures.

In climate, economy-wide measures such as emissions trading schemes will be useful to the extent that they begin building policy infrastructure that will be useful in later rounds when stronger, more generalized policy stimulus can be applied (in the same way that early building of atmospheric emissions policy infrastructure in California made later application of regulation easier). However, in early rounds they are not likely to be very effective by themselves (witness the experience of the European market), because the level of stimulus they apply will be weak and generalized rather than strong and targeted. The same general critique applies to the overarching approach of targets and timetables, when they are moderate or weak ones like those negotiated in Kyoto; they encourage an approach based on many small adaptations rather than specific major shifts. More specific commitments to particular policy measures are likely to be more targeted and exert greater leverage over industry during early phases of limited political will.

When thinking about trade and protectionism in green industry, policymakers, policy entrepreneurs, and industry representatives will need to understand that there is a balance to be struck. On the one hand, local policy that allows or encourages imports of foreign green products (such as solar panels and wind turbines) likely weakens the direct

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[357] Nygård, "Denmark: A Classic Case of a Green Spiral."

[358] Kelsey et al., "The United States: Local Green Spirals, National Ambiguity."

[359] Fischlein et al., "Policy Stakeholders and Deployment of Wind Power in the Sub-National Context: A Comparison of Four U.S. States."

[360] Pooley, *The Climate War: True Believers, Power Brokers, and the Fight to Save the Earth*.

benefit of local regulation for local manufacturers. On the other hand, to the extent that this kind of open sourcing policy encourages the growth of foreign green industry interests, it is more likely to kick off a global green spiral that will eventually result in the creation of widespread, large-scale market-creating regulation around the world, which is ultimately likely be good for green industries in all countries. [See discussion of this project's connections to literature on free trade and mercantilism below.]

Connecting Policy-Industry Feedback to Other Substantive Debates

Policy-industry feedback has potential connections to a variety of other substantive debates currently active in international relations and comparative politics literatures.

Relationship to the Path Dependence Literature – Domestic Feedback Dynamics

In Chapter 1 I briefly raised the path dependence (PD) literature as an area that featured feedback dynamics with some similarities to those I was investigating, but which typically focused on different levels of analysis. Unlike the international level of analysis, where policy-industry feedback dynamics are a relatively unexplored explanatory factor for explaining negotiation outcomes, at the domestic level path dependence literature provides a more developed body of work that examines the impact of feedback dynamics on policymaking and development. This literature concerns itself with path dependence and related concepts like evolutionary and co-evolutionary processes.

Path dependence refers to processes in which systems, such as technology paradigms, industries, or institutions, undergo self-reinforcing dynamics such that "preceding steps in a particular direction induce further movement in the same direction"[361] – in other words, they experience positive feedback dynamics. Positive feedback occurring along the course of a developing path means that progression along the path makes it increasingly difficult to reverse or deviate from the path. In many cases the end result is a situation referred to as "lock-in" – a situation in which the path dependent end result has become so entrenched or embedded that it is highly difficult to deviate from in the absence of some crisis or external disruption. Hence, lock-in explains why some systems remain in suboptimal conformations for long periods even when theoretically superior alternatives are known. For some theorists the tendency toward this state is definitional.[362]

Theorists have identified a variety of positive feedback dynamics that underpin path dependence. Arthur[363] identifies four features that theory tends to return to: significant set-up costs (which create economies of scale); learning effects; coordination effects (such as network effects); and self-reinforcing expectations. In extending the concept from technology/industry to policy and political institutions, Pierson[364] suggests that several features of politics intensify path dependence and make political lock-in states especially

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[361] Pierson, "Increasing Returns, Path Dependence, and the Study of Politics," 252.

[362] Vergne and Durand, "The Missing Link between the Theory and Empirics of Path Dependence: Conceptual Clarification, Testability Issue, and Methodological Implications."

[363] Arthur, *Increasing Returns and Path Dependence in the Economy*, 112.

[364] Pierson, "Increasing Returns, Path Dependence, and the Study of Politics."

hard to disrupt. These include the institutional density of politics (which make exit or new institution formation more difficult); power asymmetries (which give actors the ability to employ authority in ways that enhance their own power); complexity/opacity (which increases transaction costs and makes learning difficult; short time horizons (politicians focus on short-term payoffs, while shifting paths is typically costly in the short term); and status-quo bias in political institutions.

As we might expect from this summary, the most straightforward and widespread application of path dependence theory to environmental politics is to provide a useful explanation of the state of inertia surrounding many polluting technologies.[365] For techno-institutional systems like the fossil fuel-based energy system, existing investments certainly benefit from various lock-in mechanisms, such as network effects, while mature industries and firms tend not to engage in much fundamental innovation once locked into a particular technological trajectory. And the politics of energy are subject to many of the difficulties Pierson identifies. More generally, scholars have used path dependence to explain various embedded systems relevant to environmental issues.[366] Some scholars have also focused entirely on institutional path dependence, using PD to explain institutional lock-in in environmental bureaucratic and institutional entities.

The compatibility of my work with path dependence concepts should be obvious: both use positive feedback dynamics within industrial and political systems to explain evolution over time of interests and policy, leading to shifts in the range of viable outcomes. But the inconsistency should be obvious as well: path dependence theory tends to explain inertia and lock-in to existing paradigms, while my analysis finds that positive feedback dynamics can explain how countries *change* over time, from prior configurations of interests that do not support cooperation to new configurations that do. This begs a variety of questions that have theoretically productive answers: How do existing accounts of path dependence account for change? Why does my account appear to reverse the expectations of path dependence literature? Does this project add to existing understandings?

The classic explanation for emergence from lock-in, or "break out", is the occurrence of exogenous shocks or disruptive events, which have the potential to trigger sudden large-scale change. Many accounts rely on such exogenous events fairly heavily, even when they include other potential mechanisms.[367] Secondarily, there is a set of literature that examines how change may be generated exogenously within a system or occur incrementally. Important themes here are learning and innovation, and the potential for variety and recombination as a source of change. Prescriptively, these accounts tend toward advocating a grab-bag of measures or conditions that are seen as creating

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[365] Unruh, "Understanding Carbon Lock-In."

[366] Araujo and Harrison, "Path Dependence, Agency and Technological Evolution"; Ibsen and Poulsen, "Path Dependence and Independent Utility Regulation: The Case of Danish Energy and Telecommunications Regulation."

[367] Sydow, Schreyögg, and Koch, "Organizational Path Dependence: Opening the Black Box"; Unruh, "Escaping Carbon Lock-In"; Woerdman, "Path-Dependent Climate Policy: The History and Future of Emissions Trading in Europe."

supportive environments for innovation and competition.[368] In general such an environment is seen as likely to lower the costs and barriers to systemic change, although this work is often vague regarding exactly how such change occurs or how likely it is in any particular situation. Finally, the work of Eric Patashnik[369] on the durability of political reforms deals with major political changes, but is focused on how changes to constituencies can lock in significant shifts once they have occurred, rather than on how they occur in the first place.

Several articles do specifically address the potential for virtuous cycles or positive feedback that leads to the *growth* of green energy alternatives or green policy in the face of embedded carbon systems. For instance, Foxon[370] raises the possibility mostly theoretically. Jacobsson and Bergek[371] and Stenzel and Frenzel[372] both describe positive policy-industry feedback processes very similar to those I describe, underlying the growth of green industry in Germany. Aklin and Urpelainen[373] suggest a specific application of policy-industry feedback: governments may have incentives to grow supportive coalitions for their reelections, meaning that green governments should strategically overfund cleantech interests.[374]

But while these articles are in many cases excellent empirical assessments that accurately identify positive feedback dynamics underlying the growth of green policy in several cases, and (in some cases) reasonably characterize such growth as path dependent, for the most part they have not grappled theoretically with the interesting question of *why*, under some circumstances, path dependence-like processes seems to lead out of locked-in systems rather than into them. They have not for the most part addressed the question of *when* and *how* path dependent or positive feedback processes are productive of change rather than exclusive of it.

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[368] Burch et al., "Triggering Transformative Change: A Development Path Approach to Climate Change Response in Communities"; del Río and Unruh, "Overcoming the Lock-out of Renewable Energy Technologies in Spain: The Cases of Wind and Solar Electricity"; Garud and Karnøe, "Bricolage versus Breakthrough: Distributed and Embedded Agency in Technology Entrepreneurship"; Håkansson and Waluszewski, "Path Dependence: Restricting or Facilitating Technical Development?"; Jacobsson and Bergek, "Transforming the Energy Sector: The Evolution of Technological Systems in Renewable Energy Technology"; Jacobsson and Lauber, "The Politics and Policy of Energy System Transformation - Explaining the German Diffusion of Renewable Energy Technology"; Martin, "Rethinking Regional Path Dependence: Beyond Lock-in to Evolution"; Safarzynska and van den Bergh, "Demand-Supply Coevolution with Multiple Increasing Returns: Policy Analysis for Unlocking and System Transitions."

[369] Patashnik, "After the Public Interest Prevails: The Political Sustainability of Policy Reform."

[370] Foxon, "A Coevolutionary Framework for Analysing a Transition to a Sustainable Low Carbon Economy."

[371] Jacobsson and Bergek, "Transforming the Energy Sector: The Evolution of Technological Systems in Renewable Energy Technology."

[372] Stenzel and Frenzel, "Regulating Technological Change - the Strategic Reactions of Utility Companies towards Subsidy Policies in the German, Spanish and UK Electricity Markets."

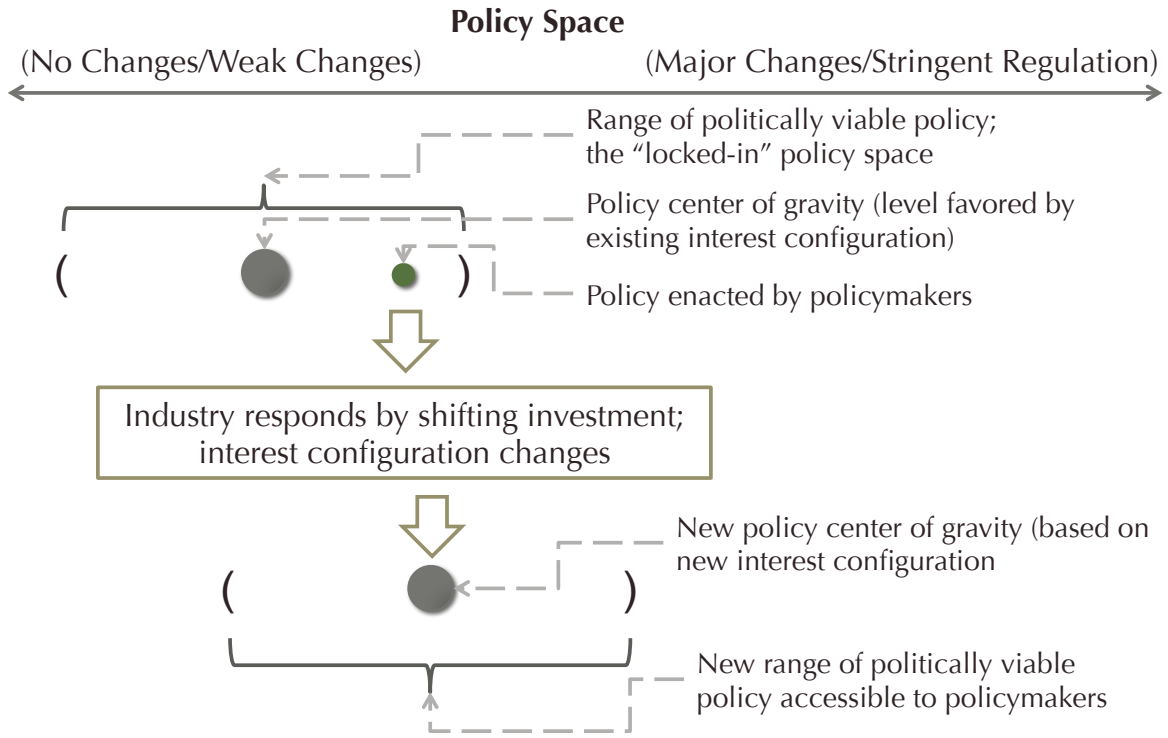
[373] Aklin and Urpelainen, "Political Competition, Path Dependence, and the Strategy of Sustainable Energy Transitions."

[374] Eric Biber's article on California (Biber, "Cultivating a Green Political Landscape: Lessons for Climate Change Policy from the Defeat of California's Proposition 23."), referenced in Chapter 5, draws on the path dependence literature as well.

My work here therefore makes two significant contributions. First, this empirical analysis suggests that there is a potent mechanism for change available when two interconnected systems, each of which has causal impact on the other, undergo a set of stepwise changes that produce a back-and-forth feedback effect. In effect, small shifts in one system ("A") act as an exogenous event for the other system ("B"), which responds by changing. Because both systems have causal power over the other, the change in B acts as a subsequent exogenous event for A, which changes responsively. This subsequent change in A acts as a further exogenous event for B; and so on.

In green policy, the policy establishment and the set of relevant industries comprise two such causally interdependent systems. On the one hand, policy structures the available opportunities for industry: if policy prohibits some activities or offers subsidies for others, industry will respond. On the other hand, industry interest configurations tend to structure the policies available to policymakers: the more a policy deviates from the ideal favored by existing industry configurations, the less politically viable it will be. But assuming there is some level of choice available in policy making (a range of politically viable policies), a trend of movement across the policy space (and away from the entrenched system) can occur if policy choices tend consistently toward one side of the viable policy space, either through random or exogenous dynamics (as in the early California case) or through the repeated actions of motivated policy entrepreneurs. Figure 14 provides a visualization of this process.

Figure 14: Policy-Industry Feedback Movement Away from Lock-In



Second, I provide some practical traction on understanding how and under what circumstances such break-out feedback occurs – certainly within the realm of environmental politics, a highly salient area for theorizing about lock-in at the moment, and likely with some potential for analogy in other issue areas. As such, this work adds to the understanding of the conditions of operation and policy implications of path dependent and path dependent-like mechanisms in energy and environmental policy. The general findings laid out in this and previous chapters apply here, as follows:

Step-wise break out is possible through skilled manipulation of policy-industry interdependence. Motivated policy entrepreneurs can exploit the range of politically viable outcomes to "walk" a system out of lock-in. However, to do so, they need to make policy with an awareness of how early policy moves will affect subsequent configurations of interests.

Understanding the mix of available industries and how to target them is key. Referring to the industry typology proposed above in Chapter 4, policymakers will be more likely to achieve break out if they consciously target policy at converting Substitutable constituencies, growing Winner constituencies, and shrinking Loser constituencies. Policies that target Management industries may achieve some policy goals but appear less likely to contribute to structural change needed for break-out.

More connectivity between international negotiations literature and examinations of feedback dynamics in national or transnational energy systems would be useful. Brewster[375] has an isolated article looking at this issue, but because of its limited scope (in terms of both cases and policies examined) its conclusions are limited and ambiguous. The work in this project suggests some of the mechanisms by which a) national and subnational policies can exert pressure to reconfigure interests across national boundaries, hence shifting foreign interests in ways that may bring host countries into closer alignment in treaty making efforts, and b) green spirals can hop boundaries through the action of treaty making efforts, as pressure from the US and the Montreal Protocol may have helped initiate a green spiral on ozone in Britain. If local green spirals can occur without international cooperation, this suggests that national action may be more achievable and (formal) international cooperation less critical than some international relations theorists believe. However, international cooperation can nonetheless be quite important both by providing impetus for national policy-industry feedback, and by helping to "transplant" such green spirals to other countries. The relationship deserves further examination.

Trade, Free Trade, and Mercantilism

The intersection of trade and environmental cooperation has typically been conceptualized in one of two contexts. First, leakage: a world of free trade supposedly renders local pollution controls on atmospheric (or oceanic) pollutants much less effective because they can simply be relocated to non-signatory countries, usually developing countries. Second, the creation of soft barriers to free trade: countries (and economists) are very concerned with the potential for environmental policy to be used as de facto trade

[375] Brewster, "Stepping Stone or Stumbling Block: Incrementalism and National Climate Change Legislation."

barriers, e.g. by developed countries that want to reduce imports from developing countries that can manufacture products at lower cost but may be less able to meet sophisticated environmental standards.

A Complex Relationship

But I want to argue that there is a more fundamental and complex relationship between free trade, mercantilism, and environmental cooperation. On the one hand, the set of concepts I have teased out in this project flirts shamelessly with neomercantilist ideas at times. The data in this work is consonant throughout with a world in which national positions in negotiations are constructed in large part from a desire to build and promote strong national industries. The ability to use industrial policy to drive national industry growth is at the heart of the green spiral concept. At the limit, these processes can take on an overtly neomercantilist tone. In ozone, early national positions were driven by the desire to break down or preserve international competitive imbalances. The US supported an international deal partly because its refrigerant producers were already dealing with regulation at home and wanted to level the playing field. European countries initially wanted to avoid regulation partly because their industries benefited from that same imbalance; their CFC producers had exploited the difference to capture much of the global CFC market. In climate, China has benefited substantially from its ability to heavily subsidize national green industries and largely reserve its huge domestic market for local green manufacturers, while also reaping the rewards of exporting low-cost products to policy-driven international markets (like Germany and California) that are promoting green energy without strong protections against foreign products. The result has been quite successful: China's solar and wind industries have both achieved global leadership, and early leaders like Vestas in Denmark are feeling the heat. It is entirely plausible that without the ability to engage in this mercantilist play, green industry would not be as big in China as it is, and hence that China would have even less incentive to tolerate carbon emissions limitations than it does today. In other words, in some cases giving mercantilist motives a certain amount of free rein might be good for environmentalism if they provide conditions that encourage the growth of supportive industries.

On the other hand, the liberal international economic order has also been critical to spreading policy-industry feedback and allowing for its transplantation between countries and across levels of analysis. The China story would not have been possible without the overarching liberal order in which China is embedded, allowing it to sell large volumes of product to foreign markets such as Germany and California. Similar dynamics show up in other cases: for instance, as I note in Chapter 5, the growth of the Danish wind industry seems to have benefited from contact with the early phases of green growth policy in California. Thus, the liberal economic paradigm at the very least seems to be good for spreading the effects of policy-industry feedback.

A recognition of this complex relationship speaks to some of the other work that has been done on the relationship of free trade and environmental (and other public goods) regulation. For instance, as mentioned in Chapter 2, David Vogel's influential work on free trade and regulation suggests several mechanisms by which free trade might

encourage the spread and strengthening of regulation[376]. First, companies looking for protection from foreign competitors might favor regulation if they can address it more easily than competitors, because it creates an advantage for them. Second, companies engaged in trade across multiple countries might favor regulatory harmonization to avoid having to deal with a patchwork of conflicting regulation; harmonization will tend to improve the standards of at least the bottom end of the regulatory spectrum. Third, companies in a country with stronger-than-average regulations and significant market and/or political power (rich, green countries) may seek to use national leverage to impose similar regulation on weaker trading partners in order to level the playing field and avoid being at a competitive disadvantage. Vogel also discusses, but does not focus theoretically upon, the potential for these mechanisms to lead to feedback effects in domestic regulation, in countries whose industries respond to foreign regulation.

But note that the role of "free trade" differs between these mechanisms. The first mechanism is actually reactive to free trade: in other words, a general environment of low tariff barriers drives protectionist companies to seek (e.g.) environmental regulation as a last protectionist resort. Mechanism two is more positive: here free trade is a driver for harmonization; but note that, as Vogel acknowledges, while harmonization brings laggards up, it can also bring leaders down (as indeed it does in some of his cases). Finally, mechanism three is less about free trade alone, and more about asymmetric interdependence and economic dependency. As Vogel notes, it is only a force for expansion of regulation when powerful countries are also green countries.

This suggests exactly the kind of complex relationship I have been laying out: in some cases or phases of development, green industry may have protectionist underpinnings, as countries and industries jockey for position and try to use regulation for comparative advantage. At that point, some level of protectionism may benefit the development of green interests and hence in the long term benefit the development of a green spiral. Free trade will tend to come into alignment with green industry interests and with international environmental cooperation when green industries in key players are large and strong enough that they want to start exporting, which will both require open markets and benefit strongly from the existence of environmental treaties that create global green markets.

Finally, there is an inherent ambiguity to mechanism two. Its immediate effects tend to push nations toward a median position, bringing up laggards but sometimes holding back leaders. Yet when harmonization begins to get traction, it also tends, as Vogel sees in Europe, to result in upward spirals of stricter regulation. Why not dead-end in a median position; or, why doesn't the median tend to move down as often as it moves up? I noted that Vogel touches on feedback mechanisms but does not develop the theme much theoretically. This dissertation, I think, makes a strong argument for why we have to place policy-industry feedback at the heart of these kinds of stories – whether international or purely domestic. Focusing on feedback lets us understand why, for instance, free trade tends to produce upward spirals of regulation rather than simply dead-ending in harmonization. It also allows us to explore exactly how such spirals are created.

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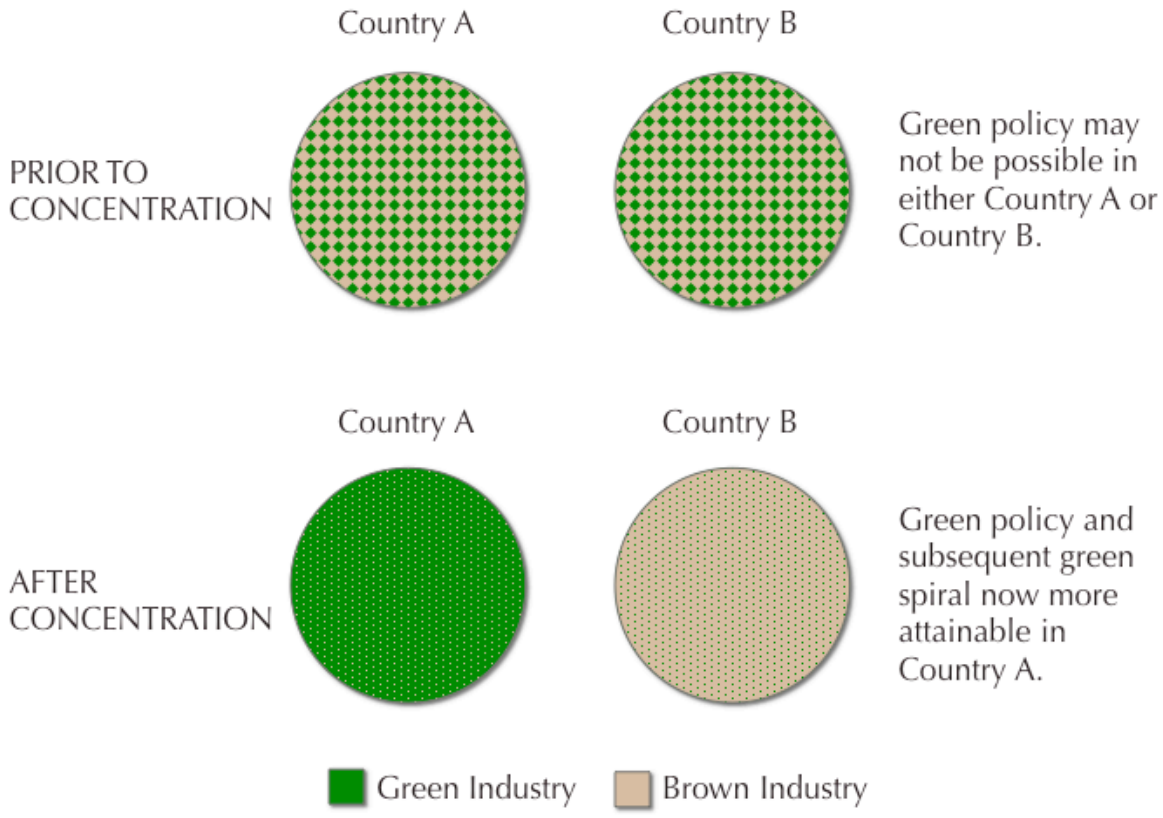
[376] Vogel, *Trading up: Consumer and Environmental Regulation in a Global Economy*.

Offshoring of Brown Interests and the Creation of Green Interest Incubators

My cases also suggest that the capacity for local specialization and concentration of industry, dependent on a liberal trade environment, may be beneficial for developing green spiral processes. The "offshoring" of oil interests in both California and Denmark, while not an intentional process designed to initiate a green spiral, may have been helpful in laying the groundwork for one. This suggests that one effect of specialization may be to allow the local concentration of green interests to increase in a way that might be productive of green spirals (see Figure 15). In the short term this might simply result in a different equilibrium, with higher concentrations of green industry in one area but higher concentrations of brown industry in another. However, in the long term, the practical effect of green spirals is to actually change the playing field by allowing a process of policy experimentation, new industry development, and innovation that would not otherwise have been possible. Such processes might in the long term create novel interest coalitions, practical technologies, and policy models that allow for the phasing out of brown interests entirely. A country with a strong, concentrated green industry constituency in California and a strong, concentrated fossil fuels industry in Texas may be a better seedbed for a national green spiral than a country that has little commercial green industry and a more diffuse fossil fuels industry. At the very least, the long-term effects of such processes merit further investigation.

Figure 15: Effects of Industry Concentration on Capacity for Green Policy/Green Spirals



Industrial Policy

Another strand of literature implicated here is the broad literature on industrial policy. This project on policy-industry feedback offers an interesting variation on this literature. The focus in research on industrial policy has been on how governments guide and manipulate the formation and evolution of industries. In such research, the independent variable is government policy, the dependent variable is industry outcome, and the presumptive goals are economic: the growth of desirable industries and the attendant positive side effects of such growth. The focus is on how (or indeed if) governments can engineer positive economic outcomes.

The content of my project has also focused on the relationship of government policymaking and changes in industry. But the focus of my work differs in several ways. First, my model suggests that there is a feedback relationship between policy and industry outcomes, and that causality as a result runs in both directions simultaneously. Both policy and economic outcomes function as independent and dependent variables, in a co-evolving relationship. Where industrial policy typically frames economic outcomes as the "goals" of interest, with policy as a subordinate tool for manipulating these outcomes, my framework views policy outcomes as the "goal" of interest, with economic outcomes as an intermediate variable that might be manipulated with the ultimate goal of shifting the viable scope of policy.

The outcome of interest is thus a political one, but the route there draws on concepts that are essentially those of industrial policy: how do governments shift industry, especially by shifting the location of sunk capital? This is therefore a worthwhile lens through which to reconsider our understanding of the goals, tools, and effectiveness of industrial policy.

Regulatory Capture

This project also has obvious connections to the literature on regulatory capture, the process in which industries exert influence over regulatory bodies, and regulatory bodies become oriented toward the needs of industry. This results in policymaking that is designed to support the particular interests of industry, rather than pursing broader societal interests; it is generally seen as a negative outcome. What my research is essentially suggesting is that such a process can occur in reverse, with policy acting on industry over time in ways that align industry with policy entrepreneurs' interests and goals, making it easier for policymakers to pursue those goals. Indeed, I argue that some of my cases represent just such a process. In such a case, the alignment of interests between policy and industry is a positive rather than a negative force. Moreover, this should be true for both sides; in the long term, this process only works to the extent that it is building real industrial strength through businesses that can make real profits and constitute a real economic interest.[377]

[377] For more extensive discussion of the issue of regulatory capture in the context of policy-industry feedback dynamics, see Eric Biber's work on California (Biber, "Cultivating a Green Political Landscape: Lessons for Climate Change Policy from the Defeat of California's Proposition 23.")

Potential Scope of the Mechanism and Areas for Future Research

For project scope reasons, I have framed this as a theory of environmental negotiations. In fact, it is potentially more broadly relevant, with possible applications across the scope of any negotiations where national negotiating positions are at least partly dependent on the interests of domestic economic constituencies, and where the evolution of these types of interests is necessary to create political space for a full agreement.

One obvious area of potential application is in trade and trade agreements. One might ask what systematic shifts have occurred in industry interests in free trade and protectionism over time and how these may have affected the scope for liberalization of trade. Export industries in most key economies have tended to expand over time both in absolute terms and as a share of GDP; does the co-expansion of liberalization and export industries represent a case of policy-industry feedback?[378]

Similarly, this lens could be an interesting one through which to view specific economic issue areas such as the negotiations over intellectual property regimes. This is an area where industry is evolving rapidly and interests might shift quickly over time. A systematic look at industry interest configuration within key players, how such interests have responded to early policy stimuli, and how that may affect politically viable agreements over time could be of interest. Agreements over biosecurity and pharmaceutical market regulation are another potential area of interest.

A set of areas for future research thus emerges from this project. First and most broadly, I have proposed that a policy-industry feedback mechanism effectively accounts for the variance in outcomes across and within issue areas in ozone and climate; to what extent does the relevance of this mechanism generalize across cases and issue areas? I believe that the ozone and climate cases are inherently important enough in their own right that there is merit in understanding a mechanism important to them even if these cases are relatively unique and the mechanisms that drive them are not highly generalizable. However, testing the general applicability of the mechanism could expand understanding of a broader set of treaty making efforts and would also be useful in establishing scope conditions for the mechanism more precisely.

Does the mechanism generalize to other forms of negotiations such as those over trade or other economic issues? Is there evidence of policy-industry feedback as a driver or potential driver of success/failure in non-environmental areas? The typology of industries that I developed for this project likely does not generalize *directly* to other issue areas beyond control of negative environmental externalities; are there comparable or adapted issue-specific typologies that can help us understand policy-industry feedback in other issue areas?

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[378] Michael J. Gilligan's *Empowering Exporters* presents an argument that looks related on its face, but is ultimately about the power of reciprocity in trade negotiations to impel export industries to lobby more strongly for liberalization; in other words, it is an argument about better aggregation and greater salience for existing interests, not an argument about feedback and change of interests over time. (Gilligan, *Empowering Exporters: Reciprocity, Delegation, and Collective Action in American Trade Policy*.)

Looking Ahead: Prospects for Future Negotiation

The genesis of this research was an interest in the prospects for cooperation between governments on hard topics. I began looking at the climate negotiations out of a genuine curiosity over whether those negotiations had a chance of success. At the point I began my project, with the 2009 Copenhagen negotiations looming, there was a real sense that the negotiations represented a critical moment. The subsequent failure of those negotiations left many with the concern that climate negotiations were in some basic way simply too hard.

But several years later, with the UNFCCC process still limping along but not generating much forward progress, it is worth taking a step back and asking what this research tells us about the future prospects for these and other comparable negotiations. Is the current flatline state of the climate negotiations an irreparable collapse? I argue that the view offers some hope. Climate change's current situation may have analogies to the situation of ozone in the early 1980s, prior to the Montreal Protocol. Political will for international regulation in climate change is currently not strong; but parties are (still) willing to come to the table. There are some real domestic drivers of salience for the issue area across key states, such as concerns among citizens in the developing world over the global warming trend and China's growing realization that it must control emissions simply to ensure livable conditions for its citizens. Technologies needed to solve the problem do exist.

And now, finally, local stories appear to be developing in ways that could spill over into international fora, as local concentrations of regulation-adapted industry develop. It is plausible that these local stories could spread to the international level and begin driving policy-industry feedback across countries, just as local stories in the US helped initiate the green spiral in ozone.

In the current context, I believe that key questions for treaty makers and policy entrepreneurs emerge from an understanding of policy-industry feedback. How can we prevent the derailment of existing green spirals; provide fertile ground for more of them; and assist them in moving up a level to international arenas, where they could drive a successful treaty making process? My goal for this dissertation was to make a start at answering that question. I suggest that the current UNFCCC approach, focused on incremental increases in targets and timetables, has not been well suited to the task. It is possible that novel approaches will grow out of the existing structure as countries seek ways to make gains in side negotiations or less formal interim agreements. Or perhaps ad hoc negotiations, such as the meetings of key players that have been attempted, can in the future build on internal momentum within players whose interests may be shifting over time, to achieve agreements (formal or informal) that produce more useful policy stimulus. Either way, it is my hope that this research project suggests some productive ways to think about negotiations as negotiators continue to seek ways to move forward.

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