The Birth of a Bioeconomy:

Growing and governing a global ethanol production network, 1920-2012

By

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Abstract

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Keywords: ethanol, biofuel, Brazil, the United States, renewable energy, low-carbon development, industrial policy, political culture, sociotechnical imaginaries, global environmental governance, regime complex, sociotechnical imaginaries

This dissertation examines the history of ethanol policymaking and the growth of a global ethanol production network, a cornerstone of the emerging low-carbon, bio-based economy. In this way, the study also provides insights into the nature of economic and environmental governance of this bio-based economy, analyzing the effects at multiple jurisdictional levels. I conducted research in Brazil and the United States, the two countries responsible for the vast majority of global ethanol production. The dissertation draws on data collected using qualitative methods including document analysis, interviews conducted in English and Portuguese, and multi-sited ethnographic investigation at nodes along ethanol commodity chains. The dissertation is divided into two parts, in which I first analyze the social, cultural and political forces that have influenced national ethanol production and consumption strategies, practices, and policies, before turning to the contemporary transnational governance arrangements determining the low-carbon value of ethanol and other biofuels on global markets. Together, Parts I and II emphasize the role of ideas and expertise in the transformation of ethanol and other biofuels, from agricultural support crops to the first globally traded commodities to be sold with low-carbon sustainability credentials.

Broadly, the four chapters in Part I examine the ways in which governments have transformed the economic geography of ethanol production networks anchored in Brazilian sugarcane and American corn. Chapters 2, 3, 4, and 5 examine how nationally specific political cultures of economic governance have influenced ethanol policymaking. In Chapter 2, I present a new framework for understanding the relationship between ethanol policymaking and political cultures of economic governance as a way to shed

new light on the cultural and structural conditions of state support for low-carbon development. Chapters 3 and 4 address the US case exclusively. In Chapter 3, I provide a genealogical analysis of the evolution of political culture since the formation of the nation-state, tracing how key ideas and practices regarding economic governance have emerged and receded leading up through the 1970s. In Chapter 4, I weave the history of US ethanol policymaking into this genealogical analysis, using the concept of sociotechnical imaginaries to show how political culture has helped to constitute the vision, strategies and policies used to build the US ethanol statecraft. Chapter 5 applies the same analysis in Chapter 4 to the case of Brazil. The overarching argument developed is that the US and Brazil have differently governed ethanol expansion in accordance with their unique political cultures of state intervention. In addition, these cases suggest that ethanol statecraft also helps to constitute a nation's political cultures of economic governance.

In Part II, I examine one particular form of economic governance: the emerging global regime complex for biofuels governance. I shift the usual focus of policy analysis from the national level to the transnational level. I conduct a fine-grained analysis of the governance arrangements shaping the global biofuels production network. I advance the argument that a global regime complex for biofuels has emerged and indicates that the politics of expertise provide a new mode of regime complex orchestration. Chapter 6 situates global environmental governance for biofuels as part of a broader historical trend away from multilateral regimes to regime complexes. This began in the forestry sector, which I unpack to use as a critical exemplar. Chapter 7 explores how the low-carbon justification for industrial policies that have increased ethanol production and consumption around the world requires nation-states to arbitrate the meaning of "low-carbon" value through the politics of expertise. This chapter looks closely at the scientific controversy that emerged around models developed to calculate the lifecycles of greenhouse gas emissions produced by different biofuel commodity chains. Chapter 8 provides a theory of regime complex orchestration based on the biofuels regime complex. This theorization emphasizes the ways in which the regime complex structure empowers transnational networks of experts to orchestrate coordination between regimes. The experimentalist architecture of the regime complex for biofuels empowers experts to steer outcomes through think deliberation. In effect, this group of non-state actors has pulled various regimes for biofuels towards broad agreement about the value of including indirect land use change variables in GHG calculator models. Taken together, these findings offer several theoretical and practical insights into the kinds of democratic institutional capacities that are required for a just transition to a low-carbon future.

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Chapter 1 Introduction

Climate change now features prominently on public policy and societal agendas. Governments at multiple levels of policymaking have enacted what some now call "green industrial policy:" policymaking designed to encourage economic development that mitigates greenhouse gas (GHG) emissions.[1] Such policies feature prominently in the growth of transportation fuels made from agricultural crops and other forms of biomass, like ethanol and biodiesel (biofuels). Green industrial policies have also supported the growth of energy efficient building construction, renewable electricity, and other petroleum-displacing goods and services. Yet even as governments play an increasingly central role in low-carbon economic development, controversy surrounds questions of whether and how governments should support these industries.

Controversies about green industrial policy are just as much conflicts over how to mitigate climate change, as they are conflicts about who should direct the economic and sociotechnical changes inspired by climate change. This dissertation focuses on the latter set of conflicts and uses the development of ethanol to argue that there is a diversity of authoritative state and non-state practices shaping capitalism's next frontier of low-carbon accumulation. Some approaches to developing new industries and products appear to grow up outside the realm of the state, led by the entrepreneurial efforts of non-state actors, such as well-established corporations or newer 'green' entrepreneurs. Other approaches appear to be state-led, falling under the umbrella of industrial policy. Arguably, all kinds of low-carbon development practices involve some combination of public and private oversight. Yet I am most interested in understanding how state actors, institutions, and organizations figure into low-carbon development initiatives. I do this by examining the development of ethanol.

Ethanol provides a useful case to investigate the social and political processes that shape patterns of low-carbon development. Ethanol is one of the most common biofuels—liquid fuels traditionally produced from classic agricultural food crops like corn and sugarcane.[2] Most ethanol is sold to consumers as gasohol (a blend of gasoline and ethanol that ranges between 10 to 30 percent ethanol) to be used in internal combustion engines of modern light duty vehicles and even some aircrafts. Depending on the fuel mix and engine type, ethanol producers boast of their product's improvements to tailpipe emissions of carbon dioxide (CO_2), ozone-forming hydrocarbons, particulate matter, and nitrogen oxides, and its potential to provide a platform for manufacturing bio-based alternatives to petrochemicals. The two countries currently responsible for over 85 percent of global ethanol production are the US and Brazil (U.S. Energy Information

[1] Industrial policy generally encompasses any strategy that targets public resources to strategic sectors. Countries may adopt industrial policies for many different reasons, such as to correct market failures, to foster economic development or to incorporate wider strategic considerations. Green industrial policy is a term used to refer to

[2] Although recent innovations have made it possible to produce ethanol from a diverse range of biomass feedstocks (e.g. agricultural residues, municipal solid waste, forest residue, and grasses), conventional corn and sugarcane producers from the United States and Brazil, respectively, provide the bulk of ethanol consumed throughout the world.

Administration, 2017). Although Brazil has historically been the larger producer, the US began to surpass Brazil in its share of global ethanol production in 2006-2007. The vast majority of U.S. ethanol is produced from corn, while Brazil primarily uses sugar.

The growth of the ethanol industry offers a unique opportunity to study the nature of public authority in low-carbon development. As an agricultural product, ethanol's history has always been closely tied to policy-driven development. Consequently, governmental authority features prominently in the development of the ethanol industry in a way that it has not for gasoline and other fuels and petrochemicals. Compared to the petroleum-based industries that have fueled our modern economy, agricultural industries have enjoyed longer and more intimate relationships with governments in a way that other industries have not, as I show in this dissertation.

In the early 1900s, ethanol was momentarily considered a viable alternative to gasoline in both countries at the start of the automobile era. Yet it was not until the 1970s that industrial ethanol production had its first major boom during the OPEC oil price crises of the 1970s. Industrial policy for ethanol took root during this time in agricultural support policies, namely corn and sugarcane subsidies to farmers and ethanol retailers including tax credits and price supports. From these roots it grew further in the 1990s and early 2000s to include many other forms of industrial policy, including national consumption mandates, federal science and technology funding, and pro-ethanol trade agreements. In the early 2000s, governments throughout the world turned to low-carbon fuels like ethanol to reduce CO_2 emissions from transportation. Since then, new industrial policy approaches continue to emerge to support ethanol production and consumption as the platform technology for a larger, global "bioeconomy" that displaces the petroleum industry's market share for fuel and chemical commodities.

The case of ethanol also presents an opportunity to examine how our understanding of public authority has shifted since the onset of the neoliberal era. The most recent wave of low-carbon fuel policies has firmly transformed ethanol and other biofuels from their original status as value-added co-products for corn and sugarcane producers into the first globally traded commodities to be sold with low-carbon sustainability credentials. This has required new forms of coordination between a diverse mix of state and non-state actors working in multiple venues, which bring low-carbon fuel regulators from subnational, national, and supranational jurisdictions together with industry groups and NGOs to devise low-carbon and sustainability performance criteria for biofuels. Although nation-states have traditionally dominated our conception of public authority, initiatives that aim to regulate ethanol as a low-carbon fuel made from sustainably produced agricultural feedstocks reflect broader shifts in global governance under neoliberalism, in which the boundaries between public and private authority are increasingly blurred

This dissertation is organized into two separate but interrelated parts. The first part traces the evolution of ethanol policy from its start in Brazil and the US, through contemporary efforts to expand ethanol's reach as the first globally traded, low-carbon commodity. The second part looks closely at the global governance architectures that shore up ethanol's status as a low-carbon commodity. Understanding the history of ethanol policymaking in the US and Brazil as well as contemporary global governance for ethanol and other biofuels provides key insights in

to how multiple sources of public and private authority conditions green industrial policymaking and low-carbon developmental outcomes.

More specifically, in Part I, I address why, how, and under what conditions governments in the US and Brazil have supported the ethanol industry through two genealogical case studies. Each genealogy examines the evolution of ethanol policymaking in relation to national political culture (Dobbin, 1994)—specifically what I call national political cultures of economic governance—in the US and Brazil. Together, the cases show how state authority conditions patterns of low-carbon policymaking in Brazil and the US. Part I is not meant to support cross-case generalizations about ethanol development, as would traditional historical comparative analysis. Rather, I aim to show that in both countries, nationally specific conflicts about state authority versus market authority encapsulated in what I call "political cultures of economic governance" have shaped the ways in which states have developed domestic ethanol industries. I then employ the concept of "sociotechnical imaginaries" as an analytical device that helps reveal the relationship between political cultures of economic governance and industrial policymaking for ethanol.

Part II shifts to a focus on the intersection of contemporary green industrial policies for ethanol and global governance for biofuels. In these chapters, I investigate transnational accountability systems for biofuels as a low-carbon fuel. The climate justification for green industrial policy has raised questions about what is, and is not, considered "low-carbon" value, bringing industrial policymaking into the arena of global environmental governance—two policy arenas that have traditionally operated separately from one another. In Part II, I make a series of interrelated arguments about the processes and architectures that determine low-carbon value in the global ethanol production network (GPN). First, I argue that biofuels governance represents a multi-level governance system comprised of a diverse mix of state and non-state actors. Second, this multi-level governance system operates as a 'global regime complex', contrived explicitly out of the legacy of the global regime complex for sustainable forestry. Third, the regime complex structure has implications for who adjudicates low-value within the ethanol production network. In particular, I draw upon the concept of "evolutionary learning" to argue that the regime complex enables a certain group of experts to act as a central authority over the low-carbon value of ethanol and other biofuels in an otherwise decentralized governance arrangement.

The basic argument of this dissertation is that there is a diversity of authoritative state and non-state practices shaping capitalism's next frontier of low-carbon accumulation. Like the arguments presented in Part I, the arguments of Part II offer insight into the conditions, processes, and architectures involved in some of the most important decisions being made about our economies and our atmospheres. In the concluding chapter of this dissertation, I discuss the overall implications of this research for those interested in the political economy of a 'just transition' to a low carbon economy.[3]

[3] The notion of a just transition proposes the need for equity in addressing the trade-offs and conflicts inherent in the transition to low-carbon energy production and consumption (Swilling and Annecke, 2012).

1.1 PART ONE—Political cultures of economic governance and ethanol policymaking: two cases of ethanol development in the United States and Brazil

Part I of this dissertation (Chapters 2, 3, 4, and 5) examines how political cultures of economic governance have influenced ethanol policymaking. By examining the interactions between ethanol policymaking and different political cultures of economic governance in the United States and Brazil, I aim to show how the two countries responsible for the vast majority of global ethanol production and consumption have pursued different paths to arrive in similar positions in the global production network for ethanol. Understanding the similarities and differences of these two cases can shed new light on the cultural and structural conditions of state support for low-carbon development.

Policy analysts and government officials often explain state support for ethanol and other low-carbon development initiatives as efforts to address climate change, energy insecurity and international competitiveness in the global economy. As US President Barak Obama proclaimed in a 2009 speech: governments must make "strategic decisions about strategic industries" ostensibly because "The nation that leads the world in creating new energy sources will be the nation that leads the 21st-century global economy" (Obama, 2009). The speech foreshadowed the roll out of his national stimulus plan, which earmarked billions of public dollars to fund innovation in renewable energy, high-speed rail, and alternative fuel vehicles. That a sitting US president made public overtures to industrial policy—a topic considered taboo in policymaking centers throughout the world since the onset of major neoliberal institutional change in the 1980s—was striking.[4] By the following year, The Economist proclaimed a "global revival of industrial policy," citing a handful government leaders in other capitalist countries who had made a similar rhetorical turn toward industrial policy after the 2008 financial crisis.[5]

To the extent that governments desire industrial policy to double as climate policy, a common script often appears. Publicly, officials cite the political impossibilities of strong climate regulation as well as the market's failure to internalize the true cost of GHG emissions, leaving private sector investors without the necessary incentives to invest in alternative energy technologies that will be the lynchpins of the transition to a low-carbon economy.[6] Proposals for green industrial policies are couched in the discourse of temporary state intervention and free market boosterism. Any state correctives to market failures must promise not to veer too deeply into state activism and to avoid the inefficient—and potentially corrupt—practice of "picking winners."[7]Accordingly, governments pursue market-friendly interventions while strengthening their commitments to the free movement of goods and people. Science and Technology (S&T) policy promises to seed a diverse field of technological development carried out by a nation's innovation system. At the same time, the state reinforces its commitments to open markets as a way to ensure that competitive forces will eventually push the best of these technologies from

[4] For a discussion on industrial policy debates over the 1980s, see Graham (1992).
[5] "Industrial policy is no longer taboo," says Mario Monti, a former EU competition commissioner. See The Economist (2010).
[6] See Rodik (2014), Karp and Stevenson (2012), Fankhauser et al. (2013), Acemoglu et al. (2012) for discussions on technological driven growth as a strategy for climate change mitigation.
[7] For a good discussion on the techno-optimism relevant to climate change, see Huesemann and Huesemann (2011).

government-supported labs to market-driven exchange relationships.[8] Technology transfer and private sector resources will facilitate the full blossoming of green technological innovation into economies of scale. It follows that government-supported technological silver bullets will not only solve climate change but also advance new winners in the global economy.

The underlying logic and attending methods of this script are not limited to alternative energy. It is a script that appears throughout the global capitalist system in the diverse policy contexts that have been touched by neoliberal regulatory change since the 1970s. Processes of "neoliberalization" (Brenner et al. 2010) can be understood as a particular form of "regulatory reorganization" that involves "the recalibration of institutionalized, collectively binding modes of governance, and more general state-economy relations, to impose, extend or consolidate marketized, commodified forms of social life" (p. 330). One manifestation of neoliberalization is that official justifications for state intervention are based on diagnoses of market failures in the form of undesirable externalities, inadequate competition, and/or the need for national self-sufficiency (Peet, 2001), and the remedies prescribed to treat these symptoms vary in doses of deregulation, marketization, privatization, and public asset-stripping (Harvey, 2005). Transposed to the arenas of industrial policy and economic development policy, neoliberalization provides a distinct epistemological, methodological and political orientation for state intervention. To remedy stagnant growth or lost competition, government turns its attention to boosting the supply of inputs that can improve a nation's "comparative advantage"—the cornerstone of mainstream trade theory. Government may target public investment to increase the "supply" of R&D programs, infrastructure, risk capital, public education, worker training programs, and export-promoting activities. Such tactics may also help attract private investors to specific sectors.[9] At the same time, governments seek to strengthen property rights and the enforcement of contracts, for example by investing in technology transfer programs alongside the development of global intellectual property rights regimes.

The ethanol sector provides one window into how neoliberalization has unfolded on the ground. During the last ethanol boom in the mid-2000s, officials from Brazil and the US similarly justified increases in government support. They spoke of a global ethanol market that would provide new market share to farmers, agricultural processors, and technology input firms in the energy, chemical and biotechnology industries, while mitigating climate change, increasing energy security, and boosting economic growth both within and beyond their national borders. To achieve this, they cited investments in innovation, commitments to free trade, and programs for international technology transfer. Yet in both countries, many other ethanol policy support pillars stood just outside of the official spotlight, others still more firmly in the shadows, defying acceptable "type casting" in the neoliberal scrip. Many of these policy strategies and tools go against the neoliberal conception of industrial policy as a momentary intervention, designed in one of a number of appropriate forms such as funding for innovation, maintaining open markets, or enforcing of private property rights. These pillars include the network of low-carbon transportation fuel mandates in major fuel-consuming countries that simulate demand signals from ethanol markets globally; supportive tax credits, insurance policies, and loan

[8] One frequently cited model of how intermittent government support for R&D can correct for market failures is the US government's role in funding and carrying out research that led to the emergence of the Internet.
[9] For examples of neoliberal industrial policy measures, see Haque (2007).

guarantees for producers in the ethanol value chain, and; pricing schemes to encourage ethanol distribution and consumption.

Indeed, there are numerous exams of industrial policy practices both within and outside of the ethanol sector that do not fit this neoliberal scrip, even though the forces of globalization and neoliberalism ought to be making national approaches to economic governance in the ethanol and other sectors more homogenous. For example, North American and European governments have maintained longstanding sector specific tax policies, loan guarantees, and other vehicles to subsidize particular firms or entire industries (Block, 2008; Block and Keller, 2011; Etzkowitz, 2003; Eisinger, 1988). In a recent display of such tendencies, American and European governments devised lavish bailouts for banks and automobile manufacturers after the 2008 recession. The development states of East Asian economies are often cited as textbook examples of the initial role industrial policy can play to get new strategic industries up and running in global markets. Yet planning agencies in Japan, Taiwan and South Korea continue to rely on economic incentives to discipline and shore up domestic firms in the electronics and automobile manufacturing sectors (Wade, 1990; Johnson, 1982). In other "newly" industrialized countries, where neoliberal structural reforms have attempted to put an end to development policy executed through state-owned enterprises and import-substitution policies, the state has continued to play a strong role in supporting domestic industries (e.g. the electronic, pharmaceutical and aerospace industries of Brazil and India (Rodik, 2007, Evans, 1995).

Nevertheless, in most countries there exist powerful voices who ardently subscribe to neoliberal orthodoxy that pushes for harmonized approaches to green industrial policy, casting some practices as a gold standard while disciplining others as inefficient or politically corrupt. For instance, after more than a decade of growth in low-carbon renewable electricity production under a variety of mechanisms (e.g. low-interest government loans, tax credits, energy and environmental regulations like renewable energy portfolio standards, guaranteed purchases, domestic content requirements, and feed-in tariffs), some governmental and intergovernmental bodies have determined certain strategies to be invalid. In 2016, the German government announced the retirement of its feed-in tariff policy, which for many years provided secure prices to producers of low-carbon electricity, in order to make way for competitive auctions and volumetric targets.[10] Also in 2016, a World Trade Organization (WTO) dispute settlement panel ruled against a domestic content requirement in India's National Solar Mission (a policy that provided economic incentives to domestic manufacturers of solar cells and modules).[11]

Industry has also pushed for a harmonized approach to green industrial policy. Nowhere is this more evident than in international trade disputes over government support for alternative energy development. Perhaps the most contentious case to date has been the trade dispute between the US against China over government support for China's domestic solar

[10] See Hill (2016) for reporting on renewable energy feed-in tariffs in Germany.
[11] See World Trade Organization (2016) for the dispute settlement. The WTO generally discourages subsidies for domestic firms, but the international rules on subsidies are underdeveloped due to the practical difficulties in determining what kinds of support confer unacceptable advantages on firms from a free-trade standpoint. For the relevant WTO agreement here is the Agreement on Subsidies and Countervailing Measures, see World Trade Organization (1994).

manufacturing companies.[12] In 2014, the WTO ruled against the US for its use of countervailing duties on Chinese and Taiwanese solar products. Nevertheless, the US and other countries continue to assert that cheap Chinese and Taiwanese solar products are the result of illegal Chinese industrial policy measures, which include export promotion, subsidized land made available to developers, and an estimated $42 billion in loans from China's development bank to domestic exporting firms between 2010 and 2012. Such measures stand in stark contrast to US green industrial policy, which critics note lacks the kinds of clear national goals and state coordination demonstrated in the US's Cold War space race with the U.S.S.R., leading some to proclaim the US has lost "the green energy race."[13] In response to the US-China conflict, the US-based Solar Energy Industries Association (SEIA) has begun developing a voluntary multilateral consensus document to clarify WTO-acceptable government support programs in partnership with the Chinese Renewable Energy Industries Association (CREIA) in order to develop consensus on acceptable forms of government support. Even so, a global agreement on acceptable solar energy policy remains elusive.

That national approaches collide with broader efforts to enforce the boundaries of acceptable economic governance is a foundational premise of the research agenda for Part I of this dissertation. This view is informed by the work of economic sociologists, geographers, and anthropologists who have broken with mainstream accounts of globalization and neoliberal governance as unified, totalizing phenomena (cf. Fourcade-Gourinchas and Babb, 2002; Peck, 2005; Brenner et al., 2010; Cotoi, 2011). Their analyses conceptualize neoliberal governance as variegated, plural and heterogeneous. As Fourcade-Gourinchas and Babb (2002) demonstrate, neoliberal governance unfolds according to certain patterns of state-society relations irrespective of a nation's level of economic development, even as many nations' economic governance regimes converge in their emphasis of fiscal and monetary austerity, restoring free trade, and use of market mechanisms for regulation. The rationale and methods of adopting neoliberal policy frames depends on national institutions. For Brenner, et al. (2010) this variegation must be understood in both structuralist and post-structuralist terms. Neoliberalization is "not an all-encompassing global totality" comprised of a certain suite of regulatory experiments that try to impose universal rules upon diverse contexts; it is also the unfolding of "profound path dependencies" (p. 330-332). The result is an unevenly developed pattern of restructuring. When global "rules of the game" collide with inherited political-institutional arrangements, significant family resemblances can emerge between spaces of regulatory change (Brenner et al., 2010: 333).

Yet to argue beyond the claim that "context matters" requires moving from abstraction to empirical cases. The task at hand for analysts concerned with neoliberalization is to investigate how context creates certain patterns of regulatory activity. Making such patterns visible helps to chart what Harvey (2005) calls a "moving map of the progress of neoliberalization on the world stage since the 1970s" (p. 87). My examination of ethanol development in the US and Brazil aims to shed light on one specific site of neoliberalization: the arena of green industrial

[12] In 2012, the Obama Administration imposed punitive countervailing import duties on Chinese products including solar panels, arguing that China and Taiwan had violated the antidumping duty law by selling photovoltaic products at prices far lower than market price in order to make the products of American photovoltaic manufacturers uncompetitive and put them out of business. In 2014, the WTO ruled against the US's use of countervailing duties.
[13] For a discussion of "greentech programs" in the US and China between 2006 and 2011, see Eisen (2011).

policymaking. What conditions and forces constitute the inherited regulatory landscapes that shape low-carbon industrial development? How do inherited landscapes collide with neoliberal regulatory projects as states try to lead low-carbon development? How are institutional landscapes not only inherited, but also actively negotiated forms of statecraft?

Answering these questions requires attending to a number of possibilities. Neoliberal governance forms may work in tandem with certain forms of governance in support of particular regimes of accumulation. But it can also be the case that neoliberal governance forms bump up against other forms of governance that are based on qualitatively different political agendas, such as collective resource allocation and greater coordination between economic actors that work against certain regimes of capitalist accumulation (Jessop, 2002; Brenner et al., 2010). In either case, the study of neoliberalization requires observing "a succession of path-dependent collisions between emergent, market-disciplinary regulatory projects and inherited institutional landscapes across places, territories, and scales" (Brenner et al., 2010, p. 342).

I approach the study of such collisions through the lens of political culture. As explained in further detail below, I link ethanol policymaking to one particular slice of national political culture, what I term "national political cultures of economic governance." Through genealogical analysis, I construct two case studies of ethanol development in the US and Brazil, to show how cultural and political conflicts over the role of the state in governing the economy have shaped ethanol policymaking. By situating national trajectories of ethanol development in these struggles, the cases show that the neoliberalization depends importantly on the political cultures of economic governance that are part of a nation's inherited institutional landscape.

The argument of Part One

Together, the cases reveal how the trajectories of ethanol development in the US and Brazil have adhered to the ideational currents of national political cultures of economic governance. Political cultures of economic governance are comprised of certain metaphors, discourses, narratives, policy frames, strategies, and practices that convey dominant beliefs about how the economy functions and what forms of statecraft that dictate best practices for maintaining a society's economic functioning. I examine how political cultures of economic governance guide state actors in two forms: ideology and tradition. This approach to understating culture as a dynamic force draws upon Ann Swider's theory of culture in action (1986). However, my overall approach falls within the vein of interpretative social inquiry known as grounded theory, as discussed in the subsequent section of this introduction.

My argument unfolds in two analytical steps. First, I show how political cultures of economic governance have evolved over the course of several economic crises. I present a longue-durée analysis of the evolution of US political culture, followed by a shorter history of Brazilian political culture. While the scope of this dissertation does not include an equally in-depth historical analysis of Brazil's history, both historical cases share the same overarching genealogical structure. I trace the founding ideologies of economic governance that emerged in the early days of nation state formation and how those ideologies manifest as traditions. These traditions undergo change during national economic crises, when state actors turn back to ideology to guide their approach to economic governance. Ideology and tradition can interact in various ways. In some instances, state actors' turn to ideology inspires new policy experiments,

which in turn engender new practices, which in turn challenge older traditions. At other times, state actors seeking to implement ideology turn back to existing tradition. Thus, they may rhetorically endorse the metaphors, discourses, or narratives of a certain ideology, but implement that ideology by using traditional logics and practices about how the economy should be governed. Thus, certain political cultural features survive over periods of crisis; others get replaced when new ideologically driven strategies and practices prove to be successful. As state actors negotiate new ideologies and old traditions during crisis, they effectively renegotiate their political cultures of economic governance. In short, a nation's political culture of economic governance is dynamic, shifting over the course of economic crises.

More specifically, I contend that political cultures of economic governance evolve around nationally specific struggles over state and market authority.[14] The tension between these sources of authority has defined how the state exerts its authority over the economy, and how the economy is understood to undermine the need for state authority. These tensions play out different in each case. In the US, the struggle to reconcile two enduring logics has defined the evolution of political cultures of economic governance over the last two centuries: the logic of economic efficiency, in which the creativity of, and competition between, market actors generates the most socially desirable outcomes; and the logic of technocratic planning, in which the state expertly engineers the economy to direct economic development and sociotechnical change towards nationally desirable outcomes. The result is that US political culture of economic governance has evolved over a series of crises in which the state attempts to reconcile these two logics. The most recent manifestation of political culture from this struggle has been an adherence to the discourse of government not "picking winners" in order to let a "thousand flowers bloom." This metaphor has translated into a responsive position on the part of the US state, in which state actors looks to the initiatives of entrepreneurs and large firms to bring imagine sociotechnical change to fruition through the efficiency of market competition. Yet at the same time, the US state exerts its "hidden" capabilities in economic development to support private sector initiatives, for instance by repurposing its capacities in defense contracting and performance-based regulation to steer market actors.

In Brazil, the nation's political culture of economic governance has evolved as a struggle between the logic of transnational partnerships, in which the development and growth of the Brazilian economy are understood to depend on relationships with transnational capital; and the logic of paternal planning, in which the state exerts its capabilities preemptively and openly, as the head of a national corporatist body made up of various private organs in need of guidance towards shared national ambitions. Brazil's political culture has evolved within this tension of these two logics, generating a set of beliefs and practices for economic growth about how the state should help Brazil's industrial elite build market share domestically and abroad through a combination of state activism and adherence to the global rules of the game. Statecraft in economic governance has invariably focused on cultivating partnerships with foreign multinationals in strategic supply chains and negotiating access to global capital and markets,

[14] Polanyi described this struggle as one between the 'dis-embedding' force of the free market and the 're-embedding' efforts of social protection (Polanyi, 2001). Foucault observed this struggle in somewhat different terms, as the dual emergence of governmentality and the political rationality of liberalism in the 18th century, the latter of which has been preoccupied with the curtailment of governmental practices according to market relations (Foucault, 1989, p. 109-119).

often at the expense of attending to pressing the country's problems of vast inequality and widespread poverty. This is perhaps most apparent in the years since the neoliberal reforms of the 1990s. Despite a new institutional landscape, Brazil has reconditioned many of its traditional features of state activism.

In the second analytical step of my argument, I show how domestic ethanol policymaking reflects political cultural change. I use the concept of sociotechnical imaginaries (Jasanoff and Kim, 2009) to show that political culture help determine how states imagine the role that ethanol plays in their nation's future and which strategies they pursue to achieve those futures. Of course, there are many factors that inspire changes from one ethanol imaginary to the next. However, the cases reveal that states evoke certain political cultural features in their articulation of a nation's ethanol future, with implications for what visions and strategies states pursue, and consequently the kinds of policies passed and the material changes realized on the ground.

But, it is not simply that political culture has helped to constitute the visions and strategies of a nation's ethanol future; ethanol statecraft has also helped to constitute political cultures of economic governance. In the recent decades since the onset of neoliberal reform initiatives, both states have restructured their economies. The ethanol imaginaries that emerge during these times articulate which state capacities are needed for ethanol development. Ethanol imaginaries have helped to articulate and pilot new forms of state intervention to shore up the ethanol industry. In doing so, they help to mediate how collisions play out between a nation's longer tradition of economic governance and neoliberal ideology.

In the US, the succession of ethanol imaginaries articulated by the state from the 1970s onward have all reinforced ideological claims that government intervention in private economic affairs is the problem, not the solution, because government initiatives cannot be trusted, while simultaneously affirming certain traditions of policy-led industrial development. Early ethanol imaginaries described a future in which the state slowly weans the US transportation system off of gasoline made from oil imports using a combination of ethanol consumption mandates, loan guarantees, tax credits, and transportation policies designed to steer investments in ethanol production and create a stable market for ethanol producers. More recent imaginaries project the nation's ethanol future as a stepping-stone to establishing a global bioeconomy, in which the state indirectly steers a wider variety of US firms into international leadership, while contributing to GHG reduction. To do this without publicly violating the ideology of "not picking winners," the state relies on a combination of S&T policy, federal funding for national laboratories and research institutions to steer technological innovation, and environmental policy. The US state pursues of a national ethanol future that grows the economic power of certain groups in the bioeconomy while translating its hidden authority into statecraft exercised in a network of national laboratories and federal regulatory rulemaking procedures for clean air.

In each case, the state simultaneously addresses its particular ethanol policy problems alongside ongoing negotiations about the parameters of its economic authority in the neoliberal era. The co-production of a nation's political identity and policymaking is not unique to the case of ethanol policymaking; researchers have observed similar phenomenon in regulatory action

around new biotechnologies.[15] However, the genealogies reveal political cultures of economic governance as an important medium through which co-production occurs.

The analytical framework for Part One

My overall approach to research in Part I constitutes grounded theory, which falls within the vein of interpretative social inquiry aims to enhance our understanding of the social world, rather than enhance our power of prediction within it. In this section, I discuss the analytical framework that emerged from my grounded approach. The subsequent section details the research methods I used to gather inductive data on both the US and Brazil cases.

The claim developed in Part One of this dissertation is that ethanol policymaking must be understood in the context of a nation's broader, historical struggle to allocate power to political forces verses market forces. Ongoing societal struggles over the proper boundaries of state and market authority over economic life influence the form and content of ethanol policy initiatives. Such struggles do not impact ethanol policymaking alone, but give shape to industrial policymaking in general. However, these struggles materialize uniquely depending on the policy arena and timing. Most recently, they manifest in what Brenner et al. (2010) call "collisions" between neoliberal forms of governance and inherited regulatory landscapes. From a Foucauldian perspective, such collisions have long been a feature of the era of governmentality, in which the political rationality of liberalism continuously challenges new technologies of governance by curtailing state power in favor of freeing market relations (see Foucault, 1989 p. 109-119; Curtis, 2002: 526). As discussed in the previous section, political culture provides a medium for such struggles.

As discussed above, I argue that state actors build and implement ethanol policies according to one particular strand of political culture—what I call the political culture of economic governance. A nation's political culture of economic governance embodies the ideas, discourses, and practices that circulate throughout society about what forms of authority are acceptable in economic life. It expresses certain rationalities and normative ideas about what is "natural" or "appropriate" in matters concerning state intervention or economic development. It speaks to where societies draw the line between the decision-making competencies of political society verses market society. It contains means-end designations that serve as the basis for truth claims about how much power political actors should exert over economic life. It operates alongside structural features to condition the form and content of problem-frames and practices related to policymaking. Political culture of economic governance emanates from both state actors like politicians and government officials, as well as from civil society actors such as the opinion leaders of industry, the academy, non-governmental organizations, social movements and the citizenry. Importantly, it is persistent and dynamic, like other forms of culture that guides

[15] Similarly, in *States of Knowledge*, Jasanoff (2006) shows how European biotechnology regulation became one of the channels by which the European Union, as a newly formed super-state, established a political identify as an independent arbiter of S&T policy matters. Thus, Jasanoff argues that periods during which society negotiates the problems of new scientific or technological orders through policy are also key episodes in which states (re) construct their political identities. Her analysis also works to re-locate the explanatory power of political culture not as an independent variable, but as in a process of co-production. My analysis also confirms some of the ideas from *Imagined Communities*, Anderson (1983), specifically the ways in which models of nation-ness, nationalism, and nation-state created from a kind of toolkit of components of political culture.

action (Swidler, 1986). Moreover, political cultures of economic governance constitute a site of negotiation, a space where society consents to or resists certain meanings.

My analysis draws upon Foucault's genealogical method to construct a critical "history of the present," one that links together a contemporary analysis of ethanol policy with a historical analysis of each nation's evolving political culture of economic governance.[16] The genealogist traces how specific contemporary practices and institutions (e.g. a particular society's death penalty) emerged from specific struggles, conflicts, alliances, and exercises of power (many of which may be forgotten) (Garland, 2014, p. 372). The goal is to critically evaluate why it is that contemporary values and taken-for-granted present-day practices are problematic. By revealing the historical conditions upon which present-day practices depend, a genealogical analysis "disturbs what was previously thought immobile; it fragments what was thought unified; it shows the heterogeneity of what was imagined consistent with itself" (Foucault, 1984, p. 82).

I trace the emergence and evolution of political cultures of economic governance beginning with a detailed case of the US (Chapter Three) and a shorter case of Brazil (Chapter Five). Both cases follow the same genealogical structure, beginning with nation-state formation in the late eighteenth and early nineteenth century. It is during this time that independence movements sprang up in the US, Brazil, and throughout the colonized Western hemisphere, to form the first political entities considered to be "nation-states" (Anderson, 1983, p. 47-82).[17] Each genealogy continues through to what some now deem to be the post-neoliberal era (See Harvey, 2012; Brenner et al., 2010). What major historical struggles prompted by political and economic crises have given form to political cultures of economic governance? What ideologies have state actors invoked in order to solve crises? How have such ideologies generated new meanings, practices, and strategies for developing, funding, organizing, and regulating economic life? Which strategies of economic governance have endured or strengthened over time and can be regarded as "tradition" (cf. ideology, as per Swidler's conception of culture in action)?

After analyzing political cultures of economic governance, I then weave the history of ethanol policymaking into the longer broader trajectories of political cultural change in the US (Chapter Four) and Brazil (Chapter Five). Here, I employ the concept of "sociotechnical imaginaries" (Jasanoff and Kim, 2009). Sociotechnical imaginaries are visions of some technology-specific future articulated by a nation's leaders for a particular political community. Whether a sociotechnical imaginary focuses on a specific technology (e.g. a specific

[16] The aim of a genealogy is to construct a critical "history of the present" derived from historical methods that identify the forces, power relations, and processes have brought some present-day phenomenon into being (Foucault, 1991) Unlike Foucault's earlier method of archaeology, the point of genealogy is to trace the process whereby the past became the present. As Garland (2014) argues, Foucault's notion of genealogy as a history of the present must be understand in the context of an explicit shift in Foucault's research from "archaeology" to "genealogy." His turn to genealogy and the history of the present came late in his career, beginning with *Discipline and Punish*. Whereas his method of archaeology aimed to reveals structural order, genealogy reveals the ontology of ourselves and of our present reality. Both involve critical historical analysis, but whereas his archeological analysis was meant to connect present day phenomenon with its origins in structural order, his genealogical analysis was concerned with determining the conditions of possibility in modern times.

[17] Anderson (1983) shows how in these places, a new kind of imagined community took hold, facilitated by the new power-languages of print-capitalism. Creole printer-journalists and administrative functionaries in the Americas helped provide a new framework of collective consciousness that generated new imaginaries of nation-ness, nationalism and nation state.

biotechnology application) or a certain sociotechnical system (e.g. nuclear power), it invokes the future—not the past—to mobilize political will for using some set of public resources to achieve said future. Sociotechnical imaginaries are a kind of statecraft. As such, they influence material outcomes, albeit less so than policy agendas and policymaking. Like other kinds of imaginaries, a sociotechnical imaginary operates through a "discursive field" to invoke certain conceptions of reality that structure how actors think and act.[18] For instance, imaginaries may call forth conceptions of the social and physical world, thereby legitimizing certain kinds of relationships, institutions and/or disciplines.[19] They invoke particular conceptions of political economy, nature, land, resources, technological innovation, production processes and social relations. Imaginaries activate collective consciousness around certain abstractions and categories that may come to be take-for-granted truths.

Ethanol imaginaries bring political cultures of economic governance to the foreground of ethanol policymaking. For each country, I use sociotechnical imaginaries as an analytical device to examine the evolution of ethanol policy in parallel with the evolution of political cultures of economic governance. This approach goes beyond tracing major ethanol policymaking events. It entails analyzing the means-ends designations of ethanol policy. What ethanol-related end goals do a nation's leaders articulate to be worth pursuing and what means do they deem appropriate to use? Why is a particular ethanol-future desirable? What risks and benefits will materialize in said ethanol future? What strategies of action and concomitant policy tools should be used to get there?

As discussed in the Conclusion, this framework constitutes an approach to understanding the 'cultural political economy' of low-carbon development, which may be useful for those interested in policymaking for 'just transitions' away from fossil fuel based economies. The "cultural turn" in political economy,[20] emphasizes the examination of the extra-economic forces that condition the form and content of a policy problem, response, or outcome—namely the cultural and structural features at work in policymaking (Jessop, 2009). At a time when governments in both developed and less developed countries are becoming more active in various green industrial policy arenas, attention to national political cultures of economic governance can help to shed new light on the reasons why low-carbon industries are developing

[18] A discursive field frames is a set of discrete but overlapping discourses and practices that frame meaning and understanding in specific ways. The discursive field structures an individual's way of being in the world, creating the possibility that only certain set of thoughts, feelings, and actions will be experienced. Foucault applied the concept of the discursive field to things like the law and the family, as a way to understand competing and contradictory discourses with varying degrees of power give meaning to and organize reality.

[19] Most notably, Anderson (1983) shows how the existence of a nation state and nationalism first requires the imagining of a national community of a deep, horizontal comradeship, and that it is this imaginary fraternity that has made it possible for millions of people throughout history to be willing to die for the vision of a community whose members will never know most of their fellow-members, meet them, or even hear of them.

[20] There are many groups of scholars associated with cultural turns in political economy. Raymond Williams, Gramsci, Thompson, Hobsbawm and his "Invention of Tradition", and more recently Jessop and Bevir from political science. The general interpretive approach here is to paint a coherent landscape that portrays how the constituent shapes sit in relation to one another, while detailing the contexts within which they operate. For policy studies, this means recognition that meaning making and policymaking are intertwined. Relations between meaning and practice affect how certain policy problems become matters of public decision-making and how certain responses come to be considered legitimate, rational solutions.

uniquely in different countries, and what those trajectories reveal about the nature of statecraft in the green economy.

1.2 PART TWO—The politics of expertise in a regime complex for low-carbon fuels

Part II of this dissertation (Chapters 6, 7, and 8) shifts to focus on the intersection of green industrial policy and global environmental governance, looking closely at transnational accountability systems for low-carbon fuels. The climate justification for green industrial policy requires nation-states to arbitrate "low-carbon" value. The most recent expansion of ethanol markets under low-carbon fuel consumption mandates has demanded that governments demonstrate the value of avoided emissions of carbon dioxide equivalents (CO_2^e) from ethanol and gasoline.[21] The need to assure the overall ecological and social sustainability of ethanol and other biofuels (including avoided CO_2^e emissions) in global trade has also demanded regulatory attention. In response, policy actors working in subnational, national, supranational and international jurisdictions have all participated in the creation of new governance systems for low-carbon fuels. This brings green industrial policy squarely into the global governance arena for climate change—two areas of policymaking that have been traditionally separate. As the remaining chapters in Part II show, global environmental politics and domestic policymaking at the national and subnational level are increasingly linked, even as global governance bodies remain a fairly insular enclave of policy activity. In is in this context that I examine the emergence of new governance systems for low-carbon fuels and the politics of expertise surrounding carbon accounting methods in these governance systems.

Ethanol is now consumed all over the world. Production remains concentrated in Brazil and the US but is increasing in other regions as well. During the initial wave of low-carbon fuel mandates that swept through Europe and North American in the early 2000s, the majority of ethanol proponents appeared to uncritically accept that substituting ethanol for gasoline would reduce CO_2^e. The logic followed that because ethanol is made from biomass feedstocks like corn, sugarcane and other plants that absorb—rather than emit—carbon from the atmosphere, ethanol must provide net environmental benefits compared to gasoline. The other commonly cited benefits of switching to ethanol from gasoline included rural economic development and the introduction of once-native crops to the contemporary landscape of industrial agriculture. However, between 2005 and 2009, an explosion of public concern about biofuels called these and other benefits into question. Scientific publications and NGO reports began documenting the range of negative impacts associated with a variety of biofuels, especially ethanol, such as the damage to ecosystems, agrarian livelihoods, human health, and food supplies. These reports made clear that the impacts of expanding ethanol and biodiesel markets could vary tremendously depending on the human and biophysical geography of biofuels production and consumption.

[21] "Carbon dioxide equivalent" or "CO_2e" is a term for describing the greenhouse gases named by the Intergovernmental Panel on Climate Change (IPCC) (IPCC, 2007) in a common unit that signifies the amount of CO_2 that would have the equivalent global warming impact. These gases include: methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), sulfur hexafluoride (SF_6), and nitrogen trifluoride (NF_3).

Ethanol proponents in powerful agri-business companies, the World Bank, and various governments promised that research and innovation efforts would soon transition the industry away from conventional ethanol to a second-generation of ethanol production systems. These newer ethanol production systems would use cellulosic biomass sources (e.g., grasses and trees) and new biotechnological engineering processes to displace the industry's more harmful production practices. Principally, these technologies can capture sugar more efficiently. Moreover, a large-scale shift to cellulosic feedstocks could help the industry meet projected increases in demand driven by government mandates in the US, Brazil, India, China and the European Union (IEA, 2011).[22] It would also address public concerns about the hazards associated with "first generation" ethanol production.[23] Cellulosic feedstocks promised to use less land and agricultural inputs, to lower emission of greenhouse gas and other pollutants throughout the ethanol lifecycle, and to facilitate more ecologically responsible and socially equitable agricultural practices (Williams et al., 2009; Lynd et al, 2008). In both Brazil and the US, governments envision cellulosic ethanol as the new basis of a more sustainable bio-economy, supplanting the fossil fuel platform currently dominating energy and chemical commodity production.

However, cellulosic boosterism has done little to assuage those concerned with the expansion of first generation biofuel systems. This is because developing and deploying cellulosic ethanol production systems has been technologically challenging and socially controversial. As the previous chapters show, bringing cellulosic technologies to the commercial scale has exposed deep and lasting ideological rifts over how governments should contribute to sociotechnical change. In addition, despite the potential efficiency gains associated with the cultivation and processing of cellulosic crops into ethanol, cellulosic crops may transform entire landscapes in ways that negatively impact biodiversity through the introduction of non-native species and destabilize agricultural communities. In addition, investment in cellulosic production systems may pose numerous other costs onto rural communities and consumers, including reduced land availability for other cultural and economic activities, depleted local water supplies, larger solid waste streams, and higher food prices (Williams et al., 2009; Sticklen, 2006).

Faced with a biofuels backlash, governments and environmental NGOs set out to develop ways to assure the public that biofuels were "greener" than their gasoline and diesel counterparts. Multiple initiatives emerged to develop sustainability standards as a mechanism to distinguish "good" biofuels from "bad" biofuels. These initiatives—most notably an initiative originating at the World Wildlife Fund in Germany—pooled together a transnational network of biofuel stakeholders from all over the world to determine the social and ecological criteria for assuring the sustainability of biofuel supply chains. However, the central focus of such initiatives quickly became how to assign a low-carbon value to the various kinds of biofuels entering the market. In the case of ethanol, policy makers in multiple jurisdictions have taken up the task by defining carbon intensity values for different kinds ethanol commodity chains.

[22] The IEA (2011) estimates a global biofuels market could provide 27% of total transport fuel used for automobiles and aircraft by 2050.

[23] The biofuel industry has been criticize for causing increases in global food price (see Rosenthal, 2011); harming biodiversity or sensitive ecological areas and releasing more CO2 into the atmosphere greenhouse gas emissions (Fargione et al., 2008; Searchinger et al., 2008); and increasing inequity in economic development (Dauvergne and Neville, 2010).

The task of making carbon valuable by making it visible enrolls a complex set of actors, socio-natures, and epistemologies. Like other fields of accounting and financial engineering, evidence of value creation hinges on transforming something that is abstract into traceable units (Bumpus, 2011). How this is done calls our attention to the politics of expertise. For example, by most calculations, the carbon intensity of ethanol made from American corn is higher than ethanol made from Brazilian sugarcane. Such determinations of low-carbon value have the power to render market conditions more favorable to Brazilian ethanol, with the implications for communities, landscapes, and atmospheres throughout the global ethanol production network. They can also reify low-carbon value determinations in other commodity chains, as well as in market-based climate governance more broadly. Collectively, the chapters in Part II explore low-carbon value creation by investigating the architectures, decision-making processes, and knowledge politics of a global regime complex for biofuels.

The argument for Part Two

In Part II, I make a series of interrelated claims. First, I show that standard-setting initiatives for biofuels sustainability should be understood as part of a larger trend away from legally binding treaties in global environmental governance, contrived explicitly out of the legacy of the global regime complex for sustainable forestry. Since the years leading up to the 1992 Earth Summit and the 1994 General Agreement on Tariffs and Trade (GATT), there has been a proliferation of sustainability standard schemes and certification programs created by public and private entities for various global environmental governance arenas, including forestry, fishing, agriculture, and most recently for biofuels. Early initiatives to develop standards for biofuels sustainability explicitly looked to forest governance as a model, specifically by fashioning the Roundtable on Sustainable Biofuels (RSB) in the mold of the Forest Stewardship Council (FSC).

Second, I propose that both the multi-level governance system for forestry and for biofuels represent global regime complexes (Abbott, 2012; Keohane and Victor, 2011), albeit with different internal dynamics. Both of these regime complexes involve a diverse mix of state and non-state actors working to create overlapping public and private regimes, which span multiple jurisdictions and scales of governance. Although a definitive feature of regime complexes is the absence of a formal, hierarchical authority (such as that which exists for a legally binding international treaty), the global regime complex for forestry demonstrates how a normative authority can emerge that influences other initiatives. In the forestry regime complex (Overdevest and Zeitlin, 2014), the FSC has served as a kind of unofficial, non-state norm entrepreneur that sets the bar for standards and definitions, pulling other initiatives to ratchet upwards. Although a subset of actors in the biofuel regime complex envisioned the RSB would assume a similar role as the FSC, that assumption proved premature. Instead, state-led initiatives working to release low-carbon fuel regulatory rules in California, the US, and various member states in the European Union empowered a transnational network of experts to adjudicate low-value within the ethanol production network.

I argue that this transnational network of experts assumed an unexpected position of normative authority in the global regime complex for biofuels. Scientific experts within this

regime complex have had deep-seated disagreements regarding how to model the lifecycle emissions of different biofuel production systems (namely whether to take a precautionary approach to modeling including indirect land use change—or "iLUC"—emissions of biofuels). In the ensuing scientific controversy over how to calculate lifecycle greenhouse gas emissions (GHGs) for different kinds of biofuels, a certain group of scientific experts successfully advocated for a precautionary approach to modeling the lifecycle emissions of biofuels by including iLUC emissions. As a result, decision-making bodies in the regime complex have largely endorsed iLUC models—despite iLUC remaining scientifically controversial. To understand how their normative authority may function as a coordinative mechanism between various regimes in the biofuel regime complex, I employ the concept of evolutionary learning (Ansell, 2011). I theorize the interactions between initiatives in a regime complex for biofuel sustainability as a constitutive process of defining the meta-norm "low carbon." This research suggests the regime complex structure facilitates some degree of cohesion through overlapping evolutionary learning processes led by a small group of scientific experts. Although the biofuel regime complex continues to evolve, there is evidence of some cohesion in the regime complex around what constitutes a "low-carbon" fuel.

The analytical framework for Part Two

Part II of my dissertation brings insights from policy studies, science and technology studies (STS), and organizational studies to bear on the global environmental politics of low-carbon energy development. My analysis draws upon the process-tracing method, which allows researchers to identify how problems are defined according to presuppositions and how a new policy resembles some existing ideal, norm, or policy principle. Process tracing creates thick description that documents how ideas travel and impact policy outcomes (Betsill and Correll, 2001). As an analytical framework, process tracing helps links the transmission of specific ideas, to decision-makers' use of said ideas, to specific political outcomes. It requires constructing a logical chain of evidence through the detailed analyses of policy documents, debates and histories. Process tracing over long intervals of time can reveal "how the structure of political discourse and language shapes how policy ideas are communicated and translated into practice" (Campbell, 2002: 32). Similarly, process tracing supports the study of "discursive institutionalism," which concerns the ways in which policy ideas, discourses, and narratives shape policy outcomes (Schmidt, 2008).

My process tracing analysis in Part II makes use of two key concepts, "regime complex" and "evolutionary learning," to show how ideas impact outcomes. Regime complexes are comprised of multiple regimes that address the same broad framework goal, such as peacekeeping or the protection of endangered species. Although researchers have traditionally described regime complexes as interstate arrangements, more recent scholarship expands the definition to include non-state actors like firms and civil society groups (Abbott, 2012; Keohane and Victor 2011). Researchers have explained the emergence of regime complexes as alternatives to single, comprehensive multilateral treaties for situations where creating a binding framework is unrealistic. Regime complexes offer a more flexible governance arrangement, one that can accommodate a diversity of policy approaches (e.g. implementation mechanisms, financing arrangements, operational programs, etc.) and multiple jurisdictional levels (e.g. inter-state commitments, legally-binding national rules).

Through the lens of regime complex theory, the proliferation of transnational standard-setting initiatives in response to the social and environmental critiques of biofuels can be understood as part of a broader trend in global environmental governance. In Chapter Six, I analyze how the institutional legacy of forest governance has influenced the way in which biofuel standard-setting initiatives have taken shape. Compared to the forestry regime complex that emerged over the course of the 1990s and 2000s, the biofuels regime complex developed relatively quickly in a span of less than a decade. I show how the emergence of a forestry governance regime complex began with the rise of private led efforts to create certification systems for sustainable hard woods, and evolved to include government-led efforts use domestic timber regulations to verify the legality hard wood supply chains. Today global governance arrangements for forests resemble a diverse organizational field, where governments, advocacy organizations, and multinational corporations have issued overlapping rules for sustainable forest management. Compared to this forestry regime complex, the biofuels regime complex developed relatively quickly through both public and private initiatives. Many of these early initiatives, especially those in launched in Europe, explicitly looked to the forest sector as a model. In particular, actors from these initiatives sought to model the Roundtable on Sustainable Biofuels (RSB) after the Forest Stewardship Council (FSC), arguing that the RSB would similarly serve as a gold standard for biofuel production chains—a central source of normative authority in an otherwise decentralized biofuel regime complex.

Despite attempts to model the RSB after the FSC, the RSB has not been as strong a source of normative authority for the biofuels regime complex as originally conceived. Important areas of standards development took place outside the purview of the RSB. Specifically, the question of how to model the lifecycle emissions of various kinds of biofuels including ethanol ignited intense scientific controversy. Disagreement emerged around the question of whether and how to include calculations for emissions from "indirect land use change" (ILUC). Government standard-setting bodies in California, the US federal level, and member states in the European Union were especially eager to resolve the issue for low-carbon fuel regulations in their respective jurisdictions. Yet, success of these regulatory processes hinged on scientific consensus regarding the most accurate way to calculate lifecycle carbon emissions of agricultural commodities. Without this, regulatory rulemaking stalled. A network of transnational experts working within and across government became central players in resolving this issue. These experts exerted normative authority in the biofuel regime complex.

To understand how experts were able to exert normative authority in the biofuel regime complex, Chapter Seven analyzes the structure of regime complexes more closely. A key characteristic of regime complexes is a lack of hierarchical authority to enforce cohesion between individual regimes, as would exist in an international treaty. As a result, there is a high degree of fragmentation between regimes in a complex. Regime complex scholars have argued that this lack of cohesion undermines the efficacy of the regime complex as a governance architecture. However, recent scholarship proposes that "experimentalist" governance processes may encourage cohesion within regimes (Overdevest and Zeitlin 2012). Experimentalism refers to a set of governance processes that begin with provisional goal setting, followed by transparent performance tracking and benchmarking performance between regimes. Ideally, this process is continuous; recursive goal-setting and evaluation ratchets upward over successive cycles and

regimes adopt the best practices developed by other regimes. When there are multiple experimentalist regimes in a regime complex, this continuous cycle can bring individual regimes into alignment on important definitions, rules and performance goals. This cycle appears to be at work in the forest governance regime complex. Yet it cannot adequately explain how alignment and coordination between regimes may be happening in the biofuels regime complex on the question of low-carbon standard-setting.

I introduce the concept of "evolutionary learning" in Chapter Eight to construct a theory of coordination in regime complexes that takes into account the politics of expertise. Evolutionary learning is a constitutional process of negotiating "meta-concepts." Meta-concepts are ideal end states; they provide "a powerful rallying point," and can serve as "the touchstone that guides the plurality of projects and goals in a common direction" (Ansell, 2011). As a process of negotiating meta-concepts, evolutionary learning can pull regimes in the same broad trajectory of change. The case of the biofuels regime complex reveals how evolutionary learning processes were facilitated by the regime complex structure. It also shows how in the context of scientific controversy, the evolutionary learning process enabled experts to exert normative authority over the low-carbon value of ethanol and other biofuels, in the absence of a centralized authority. The regime complex structure facilitates some degree of cohesion through overlapping evolutionary learning processes led by a small group of scientific experts.

In short, experts helped to chart the course of the evolutionary learning process within the biofuels regimes complex. A transnational network of scientists working across multilevel jurisdictions in California, the US, and Europe led evolutionary learning around the meta-concept "low-carbon fuel." One group of experts acted as a normative authority, by pushing for the inclusion of ILUC impacts in regulatory emissions modeling as a precautionary approach, despite the lack of scientific consensus over how to calculate these impacts. Their ability to accomplish this highlights a certain kind of boundary work that experts perform, whereby where policy makers call on experts to provide objective knowledge and experts use scientific narratives laden with their own value judgments, ethics, and politics to sway policy making. In more formal policy settings, the diffusion of scientific narratives into policy decisions can be obstructed by expectations that scientists act with disinterestedness. However, within the evolutionary learning processes that take place in a regime complex, experts' science narratives may be more influential. These narratives contain certain norms that have steered autonomous decision-making bodies in a similar direction.

The politics of expertise in this case draws our attention to the role and power of a fairly insular network of scientists in negotiating the meaning of low-carbon value in a regime complex. However, it also spotlights the ways in which non-scientific actors in a global regime complex work to legitimate certain scientific norms and narratives about the proper method for modeling the lifecycle carbon emissions. When the scientific narratives of transnational epistemic communities are taken up by political activists and professional NGOs, they can influence formal political decision-making, with implications for which biofuel producers gain a competitive edge in low-carbon fuel markets. Thus, this research demonstrates how transnational regulatory science unfolding in a particular global environmental governance arrangement constitutes a key force in the economic and political geographies of the low-carbon energy sector.

In the conclusion, I discuss the implications of this research for the political economy of a "just transition." Often, calls for a just transition are directed to states. Some argue that steering the world towards "climate compatible development" requires states develop better architectures for global energy governance (Newell and Mulvaney, 2013). As research on regime complexes indicates, such architectures may develop in an uncoordinated, decentralized fashion, involving a range of state and non-state actors from a range of jurisdictions and sectors. This raises new questions about the procedural issues involved in steering society towards low-carbon development at the transnational level. Understanding the evolutionary learning processes playing out in regime complexes spotlights a number of challenges and opportunities for those concerned with governance for socially and environmentally just transitions. Already, competing powerful interests with much at stake in the transition to a low-carbon economy hold a disproportionate amount of influence in formal decision-making fora. This work shows how technocratic decision-making processes, such as those focused on carbon accounting methods for biofuels, are largely determined by the scientific elite from the Global North. Their methodologies, modeling assumptions, and data sources transform diverse land use patterns, biological processes and production practices into calculable carbon sinks and sources, enabling low-carbon value to travel meaningfully in diverse political-economic settings. However, this research suggests the regime complex structure provides opportunities for counter-hegemonic groups to participate in, and therefore influence, the resolution of scientific controversy and expert decision-making.

1.3 Research Methods

As reflected in the organization of the dissertation, I have two major sets of research questions. Both sets of questions draw insights from a number of fields including economic sociology, science and technology studies (STS), global environmental governance (GEG), and political ecology. The first half of the dissertation investigates the cultural and structural conditions of state support for ethanol development historically through the lens of political culture. What are the different political cultures of economic governance in the US and Brazil? How have national political cultures impacted ethanol policy making? What are the similarities and differences of the two cases? And how are these differences related to political culture?

For the second half of the dissertation, I investigate the global conflicts and controversies surrounding the latest expansion of ethanol production and trade. What kinds of global governance processes and architectures have emerged for the global ethanol production network? How do public and private forms of authority figure in these governance arrangements?

The research approaches I use for both sets of questions—both the genealogical method and process tracing method described above—fall within the tradition of grounded theory. Grounded theory consists of developing systematic yet flexible guidelines for collecting and analyzing qualitative data. The goal is to construct theories from the data itself. This requires using comparative methods, gathering inductive data, and developing an iterative strategy of going back and forth between the data and analysis. Grounded theoretical approaches can enhance our understanding of the social world, rather than enhance our power of prediction within it. Like other interpretive approaches, grounded theory is premised on the idea that "since

all knowledge involves human subjectivity as its instrument or medium, no form of knowledge can be said to exist outside of the problem of interpretation" (Reed, 2011, p. 35). Furthermore, the main thrust of this research serves to highlight uniqueness and establish differences in historical developments, following cultural methodologies that focus on shared understandings at work in different societies (Lichbach and Zuckerman, 1997), rather than compare in order to establish generalizable similarities. Thus, to explain both convergence and differences in ethanol development strategies, I cast ethanol development trajectories against enduring, nationally specific political cultures.

My initial foray into this research began with the collection of case material for conducting a global production network (GPN) analysis of the ethanol industry. GPN analysis lent itself to initiating a social science analysis of the capitalistic forces, state policies, and social movements that have shaped particular industries. Conceptually, GPN analysis builds from global commodity chain analysis and global value chain analysis, all of which capture the major points of exchange and competition between firms—as bundles of capital, labor and technology—linked in a chain of transactions covering the upstream, midstream, and downstream phases of producing and selling goods in global markets.[24] These approaches emerged as alternatives to dependency theory's state-centric approach and totalizing logic of capital accumulation and globalization. Chain analyses view production activities as embedded in social relations conditioned by the nation state.[25] State actors and institutions are especially important actors: they create the systems of rules, procedures and norms that govern the behavior of market actors (Campbell et al., 1991); determine ownership and access to the resources needed for capitalist accumulation (Watts, 2012; Mitchell, 2012), and; sometimes they own and operate the means of production (e.g. state-owned oil companies) (Bridge, 2008). A number of authors have also found chain analysis conducive to investigating the ways in which cultural and economic processes are tightly bound (Collins, 2006; Dupuis, 2002). GPN analysis builds on this overall focus on the state without resorting to the state-centricity of dependency theory.

In addition, GPN also attends to the materiality of production, facilitating the examination of what Mitchell calls, "the imbroglios of the technical, the natural and the human" (Mitchell, 2012, p. 239). Production networks have material elements, including land, natural resources, technologies, transformative processes, distribution infrastructures, and consumer-facing mechanisms.[26] Attention to materiality reveals the social relations that maintain, reconfigure or establish new spaces of accumulation. Watts calls spaces of accumulation "the permanent frontier"— where key actors in the GPN negotiate who has access to and control over property

[24] Typically, upstream phases refers to natural resource extraction or cultivation; the midstream phases involve material processing and transportation, and; downstream phases involve further refining or product formulation distribution to specific consumer market segments.

[25] Chain analyses create an account of development that includes both state and corporate actors, as well as a broader range of factors, especially context-specific relationships between the firms, producers and consumers (Gereffi et al., 2005).

[26] For example, Bridge (2008) shows how the materiality of the oil GPN influences where in a chain competition over value concentrates, and also where new opportunities to create value lie. Unlike other extractive industries, the main source of competitive advantage in the oil production chain is in the exploration phase. Other extractive industries such as coal, iron ore, and bauxite mining have no equivalent exploration phase. Compared to oil, the location of reserves in these chains is generally well established as a function of physical geography and geology. As a result, the oil exploration phase is where competition and conflicts over value creation play out most intensely, and where new opportunities to create value can be found.

"through complex processes of dispossession, compromise, violence and engagement"(Watts, 2012, p. 445-6).[27] This approach lent itself to identifying shifting phases of accumulation in the history of ethanol development, as ethanol goes from a niche by-product manufactured by large corn and sugarcane processors for domestic fuel markets, to a valuable low-carbon fuel made from the sugar molecules of any plant's cell wall and sold to drivers worldwide.

GPN analysis's attention the state and materiality provided an inductive rubric for initiating data collection into how ethanol production and consumption has changed over time in a multi-level governance terrain. Understanding the geographical scope and materiality of ethanol production activities, along with the major policy jurisdictions involved in governing ethanol production and consumption helped to focus my data collection on the major policy jurisdictions governing the ethanol industry, which include national and transnational levels of governance, as well as a number of key sub-national jurisdictions, namely the states of California in the US and São Paulo in Brazil.

Below I detail the qualitative methods I used to investigate both sets of research questions for Part One and Part Two. In brief, I conducted literature reviews and analyzed primary source material (reports, minutes, presentations) collected from governmental bodies, nongovernmental organizations (NGOs), scientific research institutes and industry associations. I also conducted observational research and semi-structured interviews.

Research questions and methods for Part One

What are the different political cultures of economic governance in the US and Brazil? How have national political cultures impacted ethanol policy making? What are the similarities and differences of the two cases? And how are these differences related to political culture?

To answer question one, I developed two qualitative case studies on ethanol production in Brazil and the US, which together produce 85 percent of the world's ethanol (EIA, 2017). As two democratic governments overseeing the bulk of ethanol production within their national borders, the US and Brazil also provide a unique opportunity to examine how a newly industrialized nation often considered a leader in the periphery of the global economic system and a global economic superpower have traveled on different paths towards similar ambitions in the ethanol sector. Their paths to leadership over the global ethanol production network have converged to some degree yet remain distinct many respects. Moreover, Brazil and the US make for an interesting comparison as two of the first political entities considered to be "nation-states" (Anderson, 1983; 47-82).[28] My collection of case study material combined two approaches: a multi-sited ethnographic investigation of ethanol production and policymaking in each country

[27] Bridge (2008) shows how in the case of oil, these spaces of accumulation are conditioned by governments that control access to the core mineral assets needed for future growth. Working alongside equity partners and specialist firms, the state determine who accumulates value in the oil GPN according to who is granted access to explore. In addition, exploration of mineral assets requires knowledge-intensive techniques for discovering deep-water reserves.
[28] Anderson (1983) shows how in these places, a new kind of imagined community took hold, facilitated by the new power-languages of print-capitalism. Creole printer-journalists and administrative functionaries in the Americas helped provide a new framework of collective consciousness that generated new imaginaries of nation-ness, nationalism and nation state.

and a historical analysis of the emergence and evolution of political cultures of economic governance in Brazil and the US.

My multi-sited ethnographic investigation along the ethanol commodity chains in Brazil and the U.S. involved visits to numerous sites of ethanol production, including small and large growers of corn and sugarcane, ethanol processing plants, experimental energy crop research stations, pilot plants, and agribusiness offices in the US states of Missouri, Iowa, Illinois, and Minnesota, as well as the Brazilian states of Sao Paulo and Mato Grosso.[29] I also visited technological innovation centers and met with participants of policy-making forums that were focused on expanding the ethanol industry. I gained access to visits, meetings, and interviewees through my participation in various ethanol industry research consortia and conferences, including: (1) the Energy Biosciences Institute (EBI) at the University of California, Berkeley, and the University of Illinois Urbana-Champaign[30]; (2) the Bioeconomy Institute of Iowa State University (ISU)[31]; (3) the Fulbright Commission's U.S.-Brazil Biofuels Technology Program at the University of Sao Paulo (USP)[32]; the Advanced Research Projects Agency-Energy (ARPA-E) Innovation Summit held annually Washington D.C.,[33] and; the Ethanol Summit held every two years in Sao Paulo, Brazil.[34] These visits took the form of lab tours, attendance at presentations

[29] Site visits included touring production facilities and when possible, semi-structured interviews and informal conversations with facility owners, business managers, farm workers, and process engineers. I visited the Hickman Farm and the ICM-Lifeline Foods, a dry-fractionation commercial co-op corn mill and ethanol facility, in Saint Joseph, Missouri, and; in Iowa, the Lincolnway Energy ethanol plant in Nevada, IO, the Renewable Energy Group plant in Ralson, IO, and the Cargill headquarters in Minneapolis, MN.

[30] The EBI is a research consortium between the University of California at Berkeley, Lawrence Berkeley National Laboratory, the University of Illinois at Urbana-Champaign, and the energy company British Petroleum, the first oil company in the world to invest in ethanol production. As a researcher at the EBI, I visited the Champaign-Urbana experimental Energy Farms and attended EBI-wide research presentations and biannual conferences at UCB and UICU. The consortium supports research in a range of disciplines related to the field of energy biosciences, primarily research topics that contribute to science and technology of import to the burgeoning cellulosic biofuels industry, including agronomy, microbiology, mechanical and chemical engineering, biochemistry, chemistry, geography, economics, law and policy studies.

[31] In July 2009, I participated in the Biorenewables Program at the Bioeconomy Institute co-sponsored by Iowa State University and Cargill. As part of the institute, I visited the experimental 'energy farm' research stations, the ISU Bio-Century Research Farm, attended presentations and meetings at Cargill's Minneapolis facilities, and the Center for Crops Utilization Research, ISU.

[32] In August 2009, I participated in the Fulbright Commission Fellowship for U.S.-Brazil Biofuels Technology Program hosted by the University of Sao Paulo, Brazil, Institute of Advanced Studies, which provided the opportunity to attend industry and government presentations and conduct interviews with representatives from government and the ethanol industry including: the U.S. Department of Energy Biomass Program, Braskem, Dedini, Petrobras, the Brazilian National Bioethanol Science and Technology Lab (CTBE), the Brazilian National Institute of Metrology, Quality and Technology (INMETRO), and a number of others organizations.

[33] I attended the 2010 ARPA-E Innovation Summit in person at the Gaylord Convention Center in Washington, D.C. organized by the US Department of Energy (DOE) and the Advanced Research Projects Agency-Energy, will include the nation's leading individuals and organizations in energy innovation, including: venture capital investors, technology entrepreneurs, large and small corporations with an interest in clean energy technologies, policymakers from the Administration and Congress, and government officials from the Department of Energy and ARPA-E. That year, the theme was, "Supporting America's Breakthrough Energy Innovators," Sponsored by the U.S. Small Business Administration, White House Office of Science and Technology Policy, VantagePoint Venture Partners, and Kleiner Perkins Caufield & Byers.

34 I attended the 2011 Ethanol Summit in person at the Grand Hyatt Hotel in São Paulo. The 2011 Ethanol Summit was organized by the Brazilian Sugarcane Industry Association (UNICA) every two years, with co-sponsorship from a number of companies in the ethanol business including the U.S. biotechnology company, Amyris, British

by industry representatives and academic researchers, participant observation at working group panels, and semi-structured interviews. I also read trade presses and economic journals to figure out the structure of ethanol production networks in each country.

For the multi-sited ethnographic part of the research, my goal was not to provide a comprehensive account of a global industry, but to collect a set of situated perspectives that I could study in relation to one another.[35] In the summer of 2008, the Social Science Research Council Dissertation Proposal Development Fellowship provided me the opportunity to begin mapping out the landscape of contemporary ethanol development in each country and related policy initiatives. The Foreign Language and Area Studies Fellowship supported my first trip to Brazil that summer, where I studied Brazilian Portuguese and began crafting a research proposal. Between September 2008 and August 2012, a research grant from the Energy Biosciences Institute (EBI) "Contextualizing Bioenergy Production: Life Cycles, History and Change in Brazil" supported my fieldwork.[36]

Second, I conducted historical research on ethanol development in each country, looking closely at the logic of industrial policies. My historical analysis involved tracing (i) the national histories of ethanol production, including the changing materialities of diverse landscapes, physical resources, production technologies and industrial infrastructures that transform plant biomass into a transportation fuel and distribute it all over the world, and ethanol-consuming automobiles; (ii) the history of industrial policy for ethanol including agricultural policy, energy policy, science and technology policy, and environmental regulation, from the emergence of ethanol industries from the 1920s in Brazil and the 1970s in the US, through the expansion of global ethanol in the mid-2000s, and; (iii) the dynamic political cultures of economic governance in Brazil and the US, as discussed in further detail in Chapter 2.

For this historical component, I gathered data from a variety of sources, including government agency reports, legislative documents, presidential speeches, non-governmental policy reports, grey literature such as minutes of committee meetings, technical discussion papers, trade journals, and newspaper articles relevant to the topic of ethanol and industrial policy in Brazil and the US from the 1970s onward. I also drew from literature on US and Brazilian political economy from sociology and political science journals. Coursework at UC Berkeley in economic sociology and science and technology studies (STS) provided me the theoretical material needed to answer this question. In Brazil, I consulted with researchers and academics at a number of institutions with expertise on the ethanol industry at the Brazilian Reference Centre on Biomass (CENBIO), a bioenergy research group based at the University of São Paulo (USP), the Institute of Advanced Studies at USP, and the University of Campinas (UNICAMP) and the Center for Strategic Studies and Management (CGEE) in Brasilia. At the

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Petroleum, Honda's motorcycle division (manufacturer of flex-fuel motorcycles), and Total, the French oil giant that invested in Brazilian ethanol production. The Ethanol Summit was a key channel of information not only on Brazilian industry developments, but also policy developments in Sao Paulo state, the federal government in Brasilia, and international policy developments. I also analyzed recorded conversations and presentations made during the 2009 summit.

[35] I drew upon existing multi-sited ethnographic method for commodity chain analysis such as Collins (2005).

[36] Professors Alastair Iles and Richard Norgaard served as principal investigators on this project.

Economics Institute at the University Federal of Rio de Janeiro (UFRJ), I studied Brazilian innovation systems and policy science and technology policy.[37]

However, due to some of the complexities of conducting genealogical analysis for the Brazilian case including recent political volatility, I provide a shorter version of the Brazil case, compared to the in-depth historical analysis of the US case. While I used a similar approach to constructing each historical case, balancing the depth of detail between the two cases will be part of a postdoctoral project to develop this manuscript into a book.

Research questions and methods for Part Two

What kinds of global governance processes and architectures have emerged for the global ethanol production network? How do public and private forms of authority figure in these governance arrangements?

To answer this question, I examined critical public discourses about ethanol and followed key global governance initiatives for the biofuels industry as they unfolded in real time and retrospectively. When I began this research as a graduate student, there was little to no information documenting the critical backlash unfolding against the biofuel industry. My data collection involved in-depth document reviews, interviews, and participant observation, as detailed below.

In 2007, I began developing a database on the stock of media coverage, reports by non-governmental organizations (NGOs), and scientific studies that were critical of biofuels production and its impact on social justice and the environment. This research included document review as well as pre-dissertation research in Europe. In the summer of 2007, a Pre-dissertation Fellowship from the Institute for European Studies at UC Berkeley supported my travel to Brussels, Geneva and Rome, to explore how these debates were taking shape in Europe among major government and non-governmental entities with global influence. In meeting with program researchers at the United Nations (UN) Food and Agricultural Organization (FAO), I learned there were three major programmatic initiatives for biofuel sustainability underway: (1) the FAO International Bioenergy Platform; (2) the World Wildlife Fund (WWF)'s Bioenergy standard setting initiative; and (3) a partnership between the United Nations Environmental Program (UNEP) and Daimler Chrysler. These three initiatives were conceptualizing an international assurance scheme for producers of biofuels (selling to transportation markets) and bioenergy (selling to electricity generators) to demonstrate the sustainability of their production processes. I subsequently learned about a variety of other public and private initiatives that had just launched to create criteria for sustainable biomass production and/or implement a certification concept for biofuels trade. These included the Global Bioenergy Partnership (GBEP), the Roundtable on Sustainable Biofuels (RSB), as well as a number of national and sub-national regulatory initiatives. Governments in the Netherlands, the UK, Germany, the US and California had convened various committees, expert working groups and consultants to start developing sustainability standards for low-carbon fuels. Compared to the international multi-

[37] Professor Ana Celia Castro hosted me as a visiting researcher.

stakeholder initiatives, these government-led efforts focused more narrowly on developing methodologies to measure the GHG benefits of biofuels used in transportation.

Between 2008 and 2012, I tracked these sustainability standard-setting initiatives for ethanol and other biofuels, paying close attention to the nature of debates about how to design standards without creating non-tariff trade barriers and what the implications would be for the different kinds of ethanol getting preferential market access. I also observed how points of intersection unfolded as these initiatives matured. By 2009, technical questions about what constitutes a "low-carbon" biofuel had become a source of controversy among scientists and a key focus for all of these efforts, which created a kind of connective tissue that linked together all of these initiatives across multiple jurisdictions. As a result, my attention narrowed to the scientific debates about which methodologies were most accurate for calculating the lifecycle GHG emissions for biofuel. The bulk of this research involved document analysis, including reports by NGOs, government agencies, private consultants and university researchers on lifecycle analysis (LCA) for biofuels as well as the more general topic of biofuel sustainability standards; newspaper articles; internal meeting minutes, presentations and various kinds of grey literature from the various initiatives mentioned above; scientific journals; and various draft standards. I kept track of how scientific debates about LCA for biofuels played out in regulatory proceedings and research programs at the Environmental Protection Agency (EPA), the California Air and Resources Board (CARB), and the European Commission's Joint Research Center (JRC).

I also joined as a participant observer in open conference calls hosted by the Roundtable on Sustainable Biofuels (RSB) and attended an RSB stakeholder meeting in San Francisco. I attended a variety of meetings in Brazil on the subject of sustainability impacts and GHG accounting, given the impact these governance initiatives were poised to have on Brazil. These included presentations made corporate representatives at various ethanol production sites in Mato Grosso and Sao Paulo during my 2008 visit with the EBI research team; a 2008 meeting at the headquarters of Brazilian Sugar Industry Association in Sao Paulo; presentations by the Brazilian Institute for International Trade Negotiations (ICONE) at the Institute of Advanced Studies USP in 2009 and the Ethanol Summit 2011, both in Sao Paulo, and; by representatives from various Brazilian civil society and environmental NGOs attending a series of workshops hosted by Professor Renata Marson Teixeira de Andrade of the Catholic University of Brasília (UCB) to discuss sustainability impacts and human rights violations in the ethanol industry in 2010.

1.4 An overview of the dissertation

This dissertation is divided into two self-contained but interrelated parts. My discussion above has laid out the chronological order of the dissertation chapters, but with a focus on summarizing the arguments and supporting analysis. To briefly review, the chapters in Part One look critically at the political cultures of economic governance that have shaped ethanol policymaking. Chapter Two explains the analytical framework of Part One in detail. I discuss my definition of political cultures of economic governance, situating it in interdisciplinary social science literature. I also explain my use of sociotechnical imaginaries as an analytical device that helps link political cultures of economic governance to ethanol policymaking. This chapter sets

up the next three empirical chapters. In Chapters Three and Four, I address the US case exclusively. Chapter Three details the evolution of political culture in the US, from nation-state formation through the current era. Chapter Four presents an analysis of ethanol imaginaries in the US to demonstrate how political cultures of economic governance are at play in ethanol policymaking. In Chapter Five, I present the Brazil case. The political cultural analysis of the Brazil case does not parallel the US analysis and is much condensed. Develop a more elaborate case was outside the scope of this dissertation and will be conducted for the postdoctoral project. However, the analysis of ethanol imaginaries in the Brazil case matches the US analysis.

In Part Two "Governance," I transition from looking at the historical development of domestic ethanol industries to examine a transnational site of industrial policy-making for ethanol. I look closely at the various initiatives, actors, architectures, and processes involved in devising low-carbon fuel standards and sustainability standards. Chapter Six introduces the concept of regime complexes. This chapter provides an in-depth look at the regime complex that has emerged for forests in order to tell the story of how biofuels governance emerged from the legacy of forest governance. In Chapter Seven examines the regime complex for biofuels, including its emergence and evolution. I discuss why a variety of actors tried to replicate the governance model of the forestry sector, and explore similarities and differences between the two regime complexes. I argue that whereas the Forest Stewardship Council exerts normative authority in the regime complex for forestry, a transnational group of experts emerged as normative authorities in the regime complex for biofuels. This chapter concludes with a discussion of the network of experts that emerged during the controversy over modeling indirect land use change (ILUC) emissions. Chapter Eight attempts to theorize normative authority in the biofuels regime complex by introducing the concept of evolutionary learning. In the conclusion, I revisit the findings of both Part One and Part Two and discuss their implications for calls for a just transition to a climate friendly economy.

Chapter 2 Political Cultures of Economic Governance

Part One of this dissertation presents a genealogical analysis of the relationship between political cultures of economic governance and ethanol statecraft. My aim is not to suggest that policy is over-determined by culture. There is no question that a number of factors are important to state-led low-carbon development, such as a nation's comparative in producing emission reductions and the pressure exerted by interest groups on legislatures and government agencies. But political and economic pressures are only part of the story. The rise of today's ethanol industries is not simply the product of interest-group politics and rational policy responses to the problems posed by energy security and climate change. They are also products of national political cultures. States pursue ethanol support policies according to one particular strand of political culture—what I call the political culture of economic governance.

I define a nation's political culture of economic governance as a dynamic set of ideas, discourses, and practices that circulate throughout society that speak to what forms of authority are acceptable in economic life. Political cultures of economic governance express certain rationalities and normative ideas about what is "natural" or "appropriate" in carrying out economic governance. It contains means-end designations that serve as the basis for truth claims about where the boundaries lie between political decision-making and market forces. It contains the taken-for-granted assumptions that decision-makers use to define the policy frames and solutions for economic governance. Political cultures of economic governance emanate from state actors like politicians and government officials, as well as from civil society actors such as the opinion leaders of industry, the finance sector (e.g. investors, banks, hedge funds), the academy, non-governmental organizations, social movements and the citizenry. Political cultures of economic governance do not operate in isolation but are given form to, and are sustained by certain structural features. Importantly, political cultures of economic governance can be both dynamic and persistent.

As discussed in this introductory chapter, a basic premise of my research is that ethanol industries are not developing in quite the same ways across different countries, and that paying attention to the institutional and cultural landscapes of particular policy jurisdictions can help to explain why that is. Political cultural analysis presents a fruitful approach to revealing why, how, and under what conditions state-led low-carbon development is happening differently in different places.

By contrast, various scholarly literatures offer frameworks to understand industrial policymaking outcomes and other state-led economic development practices as functional, rational outcomes that are somehow inevitable in a particular context. For many economic historians, this story begins with the primary extraction of natural resources from the land or sea, and evolves through successive stages of industrialization in which producers graduate to higher value, higher-tech manufacturing segments of the global economy (c.f. Wright, 1990; Rostow, 1961). Similarly, others working within more deterministic social science theories emphasize economic development as a function of the exogenous, universal economic laws, unfolding at

micro- and macro-levels, which push nations along similar policy trajectories. Such accounts imply the eventual convergence of policy practices and institutions over time, as rational actors faced with deterministic forces, progressively choose the most efficient, utility-maximizing solutions, meaning that differences will disappear with time, or lessen considerably. However, these arguments cannot explain empirically why it is that some nations have achieved similar outcomes (e.g. in terms growth rates, comparative advantage) under different institutions or policy approaches.

Political economists examining cross-national differences have done better by emphasizing how a nation's factor endowments determine what policies are needed to improve a country's comparative advantage in the global economy. Factor endowments generally include domestic producers' access to natural resources, technological capabilities, and capital-to-labor ratio. These kinds of functionalist accounts tend to under-theorize the sources of these differences. The interest-group explanations of political scientists supplement these explanations by stressing the relative power of different interest groups in society as the source of policy outcomes. While this approach offers insights into how a government chooses between competing interests, it is inadequate for understanding why one interest group wins better policy outcomes than other "stronger" groups. Nor can it explain why the choice between interest groups exists in the first place.

The "new institutionalist" approaches in political science and sociology have gone further to explain national differences and the persistence of policy outcomes and practices using comparative methodologies. Historical institutionalists from political science have argued that over time, a nation develops common expectations of how things work (Thelen, 1999; Skocpol, 1995). As formal macroeconomic institutions reaffirm these expectations, the expectations "stick", creating national institutional settings that determine the behavior of actors working within those contexts (e.g. strong and weak states; neo-corporatist and pluralist societies, liberal market economies and coordinated market economies). Whereas historical institutionalism has explained why common economic challenges (e.g. oil crises, inflation, unemployment) elicit different policy responses, the institutionalists from organizational sociology have emphasized the way in which institutions influence behavior in more subtle ways. March and Olsen (1989, p. 22) observed a "logic of appropriateness" at work in institutional life. From this view, certain policy practices and strategies persist because of there are collections of norms, rules, standard operating procedures, and taken-for-granted practices which serve as a constraining structure that limits the capabilities for certain kinds of actions (Meyer and Rowan, 1977; DiMaggio and Powell, 1983; DiMaggio and Powell, 1991). In other words, institutions provide key resources that empower or constrain certain kinds of behavior. Consequently, actors within those institutions are more or less likely to behave in accordance with what is considered rational, logical or appropriate. However, new institutionalist approaches can fall short in explaining cases where new policy practices emerge despite a lack of supportive structures, rules or resources. This raises questions about how states develop new practices without institutional support.

My approach uses political culture to examine ethanol policy outcomes as historically dependent, social and cultural constructs. Although this approach builds from the historical-comparative institutionalist approach described above, it provides a unique way to understand what leads governments to pursue specific strategies of action. Political culture is ostensibly a

simple concept, but one that has been used differently across the social sciences to describe the ways in which people's culture affects their political system, and vice versa (Chilton, 1988). Like other kinds of political culture, political cultures of economic governance guide decision-making across successive government tenures (Wallerstein, 2005). My approach draws from works in comparative political economy and comparative regulatory studies from economic sociology, science and technology studies, and cultural studies, which are discussed below. There are also a number of scholars whose research has inspired my development of this concept without explicitly studying political culture. For example, political culture can be evident in how dominant policy discourses transform new ideas into a culturally accepted form of practice. Scholars studying environmental regulatory styles have shown how neoliberal principles of market deregulation have been translated into administrative practice in very different ways across countries depending on prevailing national policy discourses (O'Neill, 2000; 1997; Vogel, 1996). A handful of other studies similarly show how when new policy ideas diffuse internationally, they are translated into national practice in unique ways that fit with prevailing national political institutions (Brinkman et al., 1986; Campbell, 2002). Dupuis's work (2002) has also been influential as a Foucauldian approach that shows how cultural ideas about nature and commerce inspire regionally distinct regulatory forms.

This Chapter Two aims to: (1) define and situate the study of political culture in the broader context of policy research and cross-national comparative studies, and; (2) introduce the concept of sociotechnical imaginaries as an analytical device for weaving each nation's history of ethanol policymaking into the genealogies of political culture begun here. The theoretical framework presented in this chapter aims to generate a genealogical analysis (carried out in subsequent chapters) that shows how each nation's political cultures of economic governance have shaped ethanol statecraft.

In subsequent chapters, I trace the emergence and evolution of political cultures of economic governance beginning with nation-state formation in the late eighteenth and early nineteenth century. It is during this time that independence movements sprang up in the US, Brazil, and throughout the colonized Western hemisphere, to form the first political entities considered to be "nation-states" (Anderson, 1983, p. 47-82).[38] Each genealogy continues through to what some now deem to be the post-neoliberal era (See Harvey, 2012). I present an in-depth historical account of the US and shorter historical analysis of Brazil. However, both cover the evolution of widely shared economic theories, norms and values about who has the authority to govern economic life and how such governance should take place.

I then argue that distinct institutionalized logics persist across successive government tenures, shaping how states "see" (Scott, 1998) the development of the ethanol industry taking place. These projected futures may be understood as "sociotechnical imaginaries" — authoritative and instrumental visions about what goals the state considers to be worth attaining for its political community and the means by which it will get there (Jasanoff and Kim, 2009; Levidow and Papioannou, 2014). Imaginaries and their concomitant policies and programs are

[38] Anderson (1983) shows how in these places, a new kind of imagined community took hold, facilitated by the new power-languages of print-capitalism. Creole printer-journalists and administrative functionaries in the Americas helped provide a new framework of collective consciousness that generated new imaginaries of nation-ness, nationalism and nation state.

inextricably tied to existing agricultural landscapes and technological systems, domestic interest-group politics, government structures, as well as unique trajectories of historic economic development.

To examine Brazil and the US in this way is to compare how a newly industrialized nation and an economic superpower have traveled from very different origins towards similar ambitions in the ethanol sector. It also highlights the similarities and differences of development practices in a coordinated market economy and a liberal market economy—two poles along a spectrum in which many variations are possible (Hall and Soskice, 2001)—have converged over the last thirty years, shedding light on different variations of market society (Block, 2012).[39]

2.1 Political culture in the study of cross-national policy differences and change

Researchers of political culture offer a unique approach to understanding cross-national differences in policy. Building from the insights from the new institutionalists described above, as well as from constructivist approaches that stress the social context and learning processes at work in policy practices, political cultural analyses view institutions as cultural artifacts. Although there is no single theoretical perspective, political cultural analyses similarly emphasize the political consequences of a nation's cultural features. Political culture can be considered a short hand expression for a collective's mind-set, akin to what Michael Polanyi (1958) called the "tacit dimension": the traditions, inherited practices, beliefs, values, practices, skills, and ideas that are shared by a group of people and cannot be adequately codified in writing or articulated verbally. Rather, knowledge of this sort is transferred between actors through experience, practice, or institutions. Similarly, scholars have studied political culture in myriad ideational forms—as ideology, worldviews, cultural frames, tropes, toolkits of action, and collective epistemes—that influence material outcomes. Political culture works through members of government and civil society as they enact their preferences for certain practices. Their choices animate the principal meaning of national laws and political institutions of that society (Feldman and Zeller, 1992; Somers, 1993; Somers and Block, 2005).[40]

Scholars of comparative politics have analyzed political culture in conjunction with the history of a nation's structural features.[41] Economic sociologist Frank Dobbin's (1993; 1994) study of 19th century railway development is exemplary in this regard, as a kind of "cultural anthropology of public policy." Dobbin (1993) tracks the emergence of nationally specific cognitive structures for political and economic organization in the US, Britain and France. In

[39] Hall and Soskice (2001) propose that capitalist economies are of two variations: coordinated market economies and liberal marked economies. More recently, Block (2012) suggested supplanting the notion "varieties of capitalism" with Karl Polanyi's "market society." This more socially-embedded view of the economy reflects state as a major actor in determining the economy since the last decades of the 19th century. Block argues that Polanyi's theory of market society better reflects modern political-economic issues than either traditional Marxism or Wallerstein's world-system theory.

[40] For example, Somers (1993) shows that in the US, a pastoral political culture expressed by social movements for democracy conjoined the universal ideals for labor rights and social rights with symbolic practices of participation and community cohesion. The resulting citizenship practices that emerged helped to constitute nation

[41] In responding to doubts about the usefulness of political culture as an independent variable, Elkins and Simeon (1979, p. 131) argue that the study of political culture "must always be comparative."

each nation, he demonstrates how these cognitive structures contain rationalized means-ends designations that serve as principles of action for organizing, funding, and regulating of railroad development. He argues that as these principles of action became institutionalized, policy makers increasingly held these principles to be immutable and natural. Thus, as state actors created new policies and strategies over the decades, they continued to rely on the principles embedded into existing policies (Dobbin, 1994). Consequently, nations exhibit unique policy approaches that not only explain development outcomes in the railroad sectors of the US, Britain and France, but also shed light on continuity in a nation's policy approach over time.

Comparative research in science and technology studies (STS) has also utilized a political cultural lens to investigate policy divergences between nations (Jasanoff, 2005; Parthasarathy, 2017). For example, Jasanoff (2005) stresses the important role of political culture in her investigation of why Britain, Germany, the US and the European Union have diverged in their governance over issues of safety, ownership, innovation, constitutional rights and bioethics in relation to biotechnology. Jasanoff's political cultural analysis of national regulatory styles contrasts with more traditional explanations of regulatory outcomes, which emphasize the top-down, structurally conditioned institutional variances across nation states. She goes beyond the formal power-centers of the state to examine the bottom-up discourses of civil society and decentralized efforts of political coalitions, where society determines what is risky or safe about biotechnology in accordance with their political culture. In this context, political culture embodies the 'soft' practices of sense-making that express situated needs for order and meaning in the face of scientific and technological change. Her approach explains why US policymakers displayed a greater concern for chemical risks in the 1980s than anywhere in Europe but subsequently shifted to greater complacency in regulating biotechnology risks in the 1990s.

Research utilizing Foucauldian notions of power have indirectly helped to lay the groundwork for studying political culture. Much of this literature suggests that the historical origins of political culture lie in the creation of new discourses and institutions that influence how collective problems are understood, legitimated, and addressed. For example, Foucault's concepts of disciplinary bio-power have informed historical research that examines how governing specific populations is inextricably intertwined with certain forms of knowledge (Mitchell 1988; Ferguson 1990).[42] A number of scholars have explored political culture more directly using Foucault's concept of governmentality. Governmentality is a "very specific albeit complex form of power" exercised through an ensemble of "institutions, procedures, analyses and reflections, the calculations and tactics" (Foucault, 1991, 101).[43] Some even suggest that

[42] For example, Mitchell (1988: 33) reveals how colonial power rendered Egypt "more readable, like a book," in order to make its activities suitable to political and economic calculations. Mitchell argues that the resulting colonial abstractions are a kind of disciplinary power that has served as a framework for circumscribing some things in Egypt into in to colonial order and excluding others. Ferguson (1990) argues that the discourse of development specialists working in Lesotho imported faulty assumptions into a livestock/range-management development project designed to create a commercial cattle industry. Although the project failed to accomplish its industrial development goals, it installed a newly empowered bureaucratic class who continue the discourse.

[43] Foucault's theory of governmentality holds that since the 16th century, a new form of political power has been continuously developing around the concept of population and the more "pastoral" functions of government. For a discussion of the emergence of the art of government in opposition to sovereignty, *See* Curtis (2002). The changing geo-political conditions of the 16th and 17th centuries (characterized by mercantilism, urban and peasant rioting, and financial crises) gave rise to the perception of population-based problems and struggles. By the late 18th century, a shift had begun, in which the basis for state legitimacy moved away from the transcendental rules of sovereignty

Foucault intended to make political culture the focus of his governmentality research agenda (See Jardim, 2013).

Foucault observed a particularly conspicuous feature of political culture. He described a political rationality of liberalism that had plagued governmentality since the 18th century. This rationality was preoccupied with the curtailment of governmental practices according to market relations (Foucault 1989, p. 109-119; Curtis, 2002, p. 526). Brown (2006) further develops this idea in the US context by showing how contemporary American political culture is the product of two forces: the political rationality of neoliberalism and the moral rationality of neoconservatism. Brown argues that the US state construes and constructs itself in these terms, and propagates this particular political culture into the citizenry via policies that figure individuals to be rational economic actors in all spheres of life.[44] Cherniavsky (2017) offers an almost inverse picture of US political culture being re-configured from the bottom up in her book. In her book, Neocitizenship: Political Culture after Democracy, she argues that US political culture has been altered by an electorate that assembles its own civic dispositions in an individualistic "point-and-click" fashion because it is no longer able to conjure a sense of shared identify. Chatterjee (2004) also provides a bottom-up view of political culture in India. He shows how the popular resistance to major development projects has generated a kind of political culture that makes it possible for marginal populations facing displacement to challenge development officials. Chatterjee argues that these marginal groups constructed a new political culture as a way to fight governmentality.

This literature helps demonstrates the ways in which political culture provides a medium for society to resist or reinforce particular technologies of state power. Political culture can function conjointly with certain technologies of domination to reinforce state authority over certain populations at particular moments in history. But, it can also constitute a resistance to

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towards an understanding of the more "pastoral" functions of government and its role in administering population. This population problematic shifted the notion of state legitimacy away from "the transcendental rules of sovereignty," towards a positive conception of power premised on the management of a population and its "economic problems" within a state territory. Underpinning this new perception of population was the concept of the "economy" as something no longer limited to the household. Here, population refers not to the sum of subjects in a physical territory, but to the general administration of "living beings" (Foucault 1989: 103-4). Such administration combines the rational analysis of political economy (cultivated through the development of state sciences like statistics) with apparatuses of security to achieve various ends related to the welfare and protection of population within a state territory. The means to achieve such ends relies upon "technologies of domination of others and those of the self" (Foucault, 1988: 19). Foucault conceptualized these technologies to be the political structure we now recognize to be "the state"—a form that is neither coherent nor monolithic, but one that continually shifts around a "tricky combination" of "individualization techniques" and "totalization procedures" (Foucault 1983, The Subject and Power). The technologies of governmentality largely function independent of citizen participation. Yet, these technologies exert very strong control over citizens' subject-formation by reinforcing particular values, ways of seeing and knowing, taken-for-granted assumptions and truth claims.

[44] Brown (2006) concludes that the US has been witnessing the decline of liberal democratic institutions and political culture. Brown (2006) suggests, political rationality is constitutive of political culture. For Brown, political rationality is a specific kind of normative political reasoning that orders the practices of governance and citizenship. Political rationality governs the domains of what is say-able and intelligible, as well as the truth criteria of each of these domains. In her study, the political rationality of neoliberalism articulates the market as natural, self-regulating, and fully institutionalized in social and economic policy; that casts political and social problems as appropriately dominated by the market, and; that produces productivity and profitability as criteria for democratic governance. She expressly distinguishes rationality from ideology.

governmentality. This suggests political culture evolves through struggle over state authority. As Foucault proposed, political struggle over state authority in the era of governmentality can no longer be simply reduced to conflicts over class relations that culminate in government takeover by a revolutionary political party. Even though there are some state functions focused on reproducing the relations of production, Foucault saw contestations over state power taking place within the very techniques and tactics that the state uses to govern its population (Curtis, 2002: 525). And herein lies the purpose of studying governmentality: to reveal how domination works through technologies of the state so that it may effectively be contested (Foucault, 1979).

Political culture as persistent and dynamic

Importantly, political cultures of economic governance must be understood as both persistent and dynamic. Like other forms of culture, political cultural features can endure over long periods, guiding decision-making across successive government tenures, contributing to the kind of path dependencies observed by historical institutionalists. Yet, political cultural features are not inherently static; they change. This dynamic quality can be understood using Swidler's (1986) theory of "culture in action." Applying this conception of culture as encompassing both stasis and change to the analysis of Brazil and the US helps explain why political cultures of economic dependence contribute to certain path dependencies in industrial policymaking, without treating culture as a totalizing force that precludes agency and change.

During "settled" times, culture influences action in the form of tradition. Tradition functions similarly to how a toolbox influences a contractor's work; it offers actors the equipment they need to construct a building. Tradition provides actors with a "cultural repertoire," filled with habits, skills, and styles that people draw from to construct "strategies of action" (Swidler 1986, 273). Tradition can take the form of widely accepted means-ends designations, well-understood causal relationships, taken-for-granted meanings, and other knowledge-based skills and practices common to a particular social group. Actors have the agency to choose from the repertoire of tradition to construct strategies of action. Yet, tradition also limits what tools are available. Swidler argues that tradition is a kind of cultural toolkit that "limits the available range of strategies of action" by creating "persistent ways of ordering action through time," thereby constraining the range of strategies actors are able to build (Swidler, 1986: 284).[45] Research from the new institutionalists in organizational sociology support this theory, showing how policy actors initiate policies or programmatic reforms follow basic social scripts, which have already been validated by the relevant cultural authorities (Scott 1995; Scott and Meyer 1994; Powell & DiMaggio 1991; March and Olsen 1989).

Although "settled times" characterize most of the time, occasionally disruptive crises of various sorts emerge. Swidler designates these "unsettled times." Swidler observes that when a community experiences crisis, the contents of the existing toolkit—the logics which were

[45] The relationship between culture and tradition is like a "switchman directing an engine propelled by interests" (Swidler 1986; 277): "If culture influences action through end values, people in changing circumstances should hold on to their preferred ends while altering their strategies for attaining them. But if culture provides the tools with which persons construct lines of action, then styles of strategies of action will be more persistent than the ends people seek to attain. Indeed, people will come to value ends for which their cultural equipment is well suited." (Swidler 1986: 277)

previously taken for granted—appear to no longer work. Actors contest and question tradition. They have less confidence that tradition can guide them to their desired end goals. Instead, they turn to ideology for guidance. Swidler (1986, 279) distinguishes "ideology" from "tradition":

> An ideology is a highly articulated, self-conscious belief and ritual system, aspiring to offer a unified answer to problems of social action. Ideology may be thought of as a phase in the development of a system of cultural meaning. "Traditions," on the other hand, are articulated cultural beliefs and practices, but ones taken for granted so that they seem inevitable parts of life.

Compared to tradition, culture in the form of ideology instructs action through symbols and metaphors that offer highly, prescriptive, consistent, albeit abstract, scripts for action. These ideologically driven scripts are often difficult to translate into action directly and thus require experimentation to develop new strategies for action. If such experiments prove successful, new strategies for action may stick, become institutionalized, and the toolkit of tradition may expand to include new repertoire(s). Or, if such new strategies prove unproductive, actors may simply turn back to tradition to guide their action. Swidler suggests that the latter is more common. In a "settled" community, ruling ideologies have evolved into a taken-for-granted system of cultural practices (Swidler 1986, 284).

Although tradition is persistent, Swidler proposes that societies are not forever stuck with one toolbox. Tradition can undergo change when crisis moments unsettle a social community, creating space for ideology to become more influential than tradition.[46] Ideology informs the indeterminate contents of a society's tradition toolkit. Looking at a community's toolkit in a particular historical moment can reveal whether that community is "settled" in tradition or "unsettled" in its ideological development. An unsettled community is similar to a community of scientists undergoing what Thomas Kuhn (1996) would call an epistemic crisis, brought about by a research paradigm coming under distress. In such historical moments, there may be multiple competing ideologies. Communities may fall back on the most dominant, familiar ideology. Or, they may become open to newer ideologies and start experimenting with new kinds of strategies of action, eventually changing tradition. Eventually, when the community resumes a "settled" existence, it proceeds with a somewhat new toolkit of tradition that guides its strategies of action. In a "settled" community, dominant or successful ideologies have evolved into a taken-for-granted system of cultural practices, or the toolkit of tradition (Swidler 1986, 284). However, whether an ideological-driven strategy has long-term influence depends on what is already in the cultural toolkit at the moment of crisis, in addition to whether there are other "structural opportunities" in place to support a particular ideology (Swidler 1986, 282).

This dynamic interplay between tradition and ideology helps explain how political cultures of economic governance evolved at various historical moments. For instance, in both cases, the national crisis set in motion by the 1929 stock market crash ushered in a turn to corporatist ideology. Although the US and Brazil began with different founding ideologies, in the years leading up to the 1930s, both nation states had adopted core tenets of classical economic theory, including Ricardo's classical theory of comparative advantage in international trade, and had experienced great prosperity from the economic stimulus spurred by World War I

[46] To understand why one ideology sticks requires going beyond this toolkit model to analyze structural constraints and historical circumstances mediating why one particular ideology beats out another to become the dominant ideology, eventually becoming tradition.

(WWI). The Brazil economy was particularly dependent on foreign markets for agricultural exports, especially coffee. The 1929 economic crash in the United States had devastating effects on domestic and international capitalism. In both countries, the crash inspired new corporatist regimes that challenged orthodox economic theory. In the 1930s, leaders in both nations were similarly inspired by corporatist ideology. Italy's National Corporatist system served as a model for architects of the American New Deal and the Brazilian Estado Novo (the New State). In each case, state actors articulated a positive role for the state in guaranteeing socially justice distribution of prosperity by managing the economy. Although each state pursued different mechanisms for government collaborations with industry cartels and labor unions, both sought corporatist ideology as a necessary alternative to their previous traditions, which had left too much of the responsibility for governance and coordination to the market. Both governments launched broad initiatives that proposed new corporatist institutions to manage interest group representation and collaboration between the state, industry cartels, and labor unions.

By the 1940s, as corporatist ideology fell out of favor, industrial elites significantly tempered corporatist planning initiatives. Yet each nation's experiment with implementing corporatist ideology generated a number of lasting traditions. States did not simply fall back on the most dominant, familiar ideology or proceed to use what was already in their cultural toolkits at the moment of crisis. Instead they incorporated some of their experiments with corporatist ideology with older traditions, and proceeded with a somewhat new toolkit of tradition. In both states, this new toolkit of tradition expressed competing logics about the role of the state in economic life, which continue to generate tensions within each nation's political culture of economic governance. In the US, these tensions are produced by two enduring logics, the logic of economic efficiency and the logic of technocratic planning. In Brazil, tensions are produced by the logic of transnational partnerships and the logic of paternal planning. I integrate the concept of sociotechnical imaginaries to show how these tensions have influenced ethanol policymaking.

The subsequent chapters examine how political cultures of economic governance have evolved in through a series of crises, in which state actors negotiate political cultural ideologies and traditions. I then trace the sociotechnical imaginaries that emerge for ethanol between 1970 and 2012, highlighting how ethanol support policies figure into these moments crisis. States see ethanol strategies through the prism of ideology or tradition, with implications for how policy makers craft ethanol policies. The main argument supported by these cases is that ethanol policy is not only a means to various ends—be it rural economic development, fuel shortages, climate change, or national competitiveness in the global economy; it is also a vehicle for renegotiating or solidifying the role of the state in economic life. In the following section, I detail my use of sociotechnical imaginaries as an analytical device that helps make political cultures of economic governance visible in ethanol policymaking.

2.2 Weaving in Sociotechnical Imaginaries of Ethanol

Political cultures of economic governance not only shape how state actors build strategies of action, but they also evolve through the strategies that state actors pursue. In other words, as state actors build new policy strategies during times of crisis or times of stasis, out of new ideologies or old traditions respectively, they help adapt a nation's political culture of economic

governance to contemporary situations. As the cases show, state actors design new ethanol policy strategies that are invariably guided by ideological scripts or traditional repertoires. Such strategies, when successful, help to validate certain features of a nation's political culture. Sociotechnical imaginaries can help to make this kind of co-production of policy and political culture visible.

Sociotechnical imaginaries of ethanol are discursive constructions of ethanol that reflect what state leaders believe ought to be attained through ethanol development projects. Such imaginaries are a kind of statecraft. As such, they influence material outcomes, albeit less so than policy agendas and policymaking. I utilize the concept of sociotechnical imaginaries as an analytical device that shows how political cultures of economic governance help determine the unique paths that states chart to grow their domestic ethanol industries. Sociotechnical imaginaries reveal differences in how state actors "see" ethanol. In doing so, they provide a useful lens to observe how state actors practice certain traditions of economic governance, or alternatively, challenge those traditions with ideologically inspired practices and meanings, in the ethanol policy arena.

Sociotechnical imaginaries are visions of some technology-specific future articulated by a nation's leaders for a particular political community (Jasanoff and Kim, 2009). They are the "collectively imagined forms of social life and social order reflected in the design and fulfillment of a nation-specific scientific and/or technological project" (Jasanoff and Kim, 2009). A sociotechnical imaginary communicates a nationally specific future in order to mobilize political action. Like other imaginaries, they are considered "representations of how things might or could or should be" (Fairclough, 2010, p. 266). They are discursively constituted by particular collectivities of people and take regional forms (Peet, 2000). They operate through a "discursive field" that structures how individual actors think and act.[47] As Jessop (2017) has argued, imaginaries speak to an important strategic dimension of the state, which is to selectively and hierarchically reduce complexity and define which interests are the objects of strategic action. Such a vision can help coordinate or orchestrate different groups by clarifying means-end designations, and enroll a diversity of agents to pursue the same vision. Imaginaries reinforce patterns of public reason about what benefits are worth attaining. The more actors, agents, and resources are enrolled in an imaginary, the more powerful the imaginary becomes.

However, sociotechnical imaginaries are distinct from other kinds of imaginaries. They explicitly focus on futures forms of social life that entwine social, natural, scientific, and technological worlds. As powerful state-endorsed vision of what the future should look like, the kinds of actions that sociotechnical imaginaries aim to inspire are unique as well. They may influence technological design and innovation by endorsing the image of a certain kind of production system, an up-and-coming innovation, or particular economic relations between supply chain actors. They may also more explicitly target some set of public resources to

[47] A discursive field frames is a set of discrete but overlapping discourses and practices that frame meaning and understanding in specific ways, thereby structuring how actors think and act by endorsing certain conceptions and categories of reality. The discursive field structures an individual's way of being in the world, creating the possibility that only certain set of thoughts, feelings, and actions will be experienced. Foucault applied the concept of the discursive field to things like the law and the family, as a way to understand competing and contradictory discourses with varying degrees of power give meaning to and organize reality.

activities that promise to achieve the imagery it projects, for instance channeling public investment to particular groups of scientists or entrepreneurs.

However, not all imaginaries are successfully operationalized and institutionalized into policy. Imaginaries are not to everyone's benefit and may be contested. Sociotechnical imaginaries may implicitly or explicitly project certain risks to be worth tolerating by some groups, while warning against imposing other risks onto other groups.[48] For instance, in their comparative studies of nuclear policy in South Korea, the US, and Germany, Jasanoff and Kim (2015) show how nuclear imaginaries justify the inclusion or exclusion of citizens with respect to the benefits of technological progress in nuclear energy.

Sociotechnical Imaginaries of Ethanol

Sociotechnical imaginaries of ethanol contain ideas about what role ethanol should play in the nation's future and the means through which a particular ethanol future should be pursued, such as the use of public and private financing strategies, land and other natural resources, technological systems, innovation-focused research and development (R&D) initiatives, industrial supply chain relationships, and regulatory institutions. Brazilian and American government visions for ethanol reflect nationally-specific zones of political and economic calculation and are rooted in material networks of actors, organizations, technologies, and ecologies that give form to the global ethanol production network. They call forth certain conceptions of the social and physical world. They invoke particular conceptions of political economy, nature, land, landscapes, public resources, technological innovation, production and transportation systems, and social relations. Ethanol imaginaries activate collective consciousness around particular relationships, institutions, disciplines, logics of economic development, and categories of knowledge within a nation's political culture of economic governance.

The cases also show that ethanol imaginaries are dynamic and contested, changing over successive government administrations in both countries. Ethanol imaginaries have focused on different goals at different historical moments, from agricultural modernization, to clean air technology, to climate change mitigation, to innovation-based competitiveness. Across all of these shifts, imaginaries remain discursively constructed from economic tradition. But they are also able to help shape the form and function of statecraft for ethanol development and, therefore, have the power to influence the material development of the state itself. By applying concept of sociotechnical imaginaries to examine the relationship between political cultures of economic governance and ethanol statecraft, I adjust the original definition offered by Jasanoff & Kim (2009).

According to Jasanoff and Kim, sociotechnical imaginaries are instruments of state power that reside somewhere between policy norms and policy agendas. I locate sociotechnical imaginaries more specifically between political cultures of economic governance and policy

[48] For example, pushing certain innovation too hard without allowing for adequate time for market testing may be invoked as a risk that must be avoided, while the real or potential manufacturing hazards of that innovation at a commercial scale for a particular community (e.g. a fence line community) are ignored.

agendas. Such a conception hones in on a specific subset of policy norms: a nation's unique reservoir of ideology, discourses, metaphors and meanings, from which state actors build their policy preferences and strategies of action for governing economic life. This analytical move enables interpreting the ways in which ethanol imaginaries not only project forward visions of a certain sociotechnical future, but also reflect back salient features of political culture.

Thus, ethanol imaginaries demonstrate how ethanol is at times both an object of industrial policy for competitive economic development and a vehicle for solidifying the role of the state in economic life. My aim is to develop this argument by showing how ethanol policy is not only a product of cultural tensions surrounding the role of the state in coordinating economic activity, but also an attempt to resolve those tensions. The analyses of ethanol imaginaries show that when macroeconomic life is fraught with uncertainty, imaginaries help states to re-interpret their political cultures of economic governance. For instance, ethanol imaginaries can provide authoritative blueprints for ethanol expansion in the context of uncertain economic prospects. As such, they become productive spaces in which new public understandings about the role of the state in economic life emerge. Ethanol imaginaries not only convey the means by which a nation's ethanol future should materialize, but also help states to address the tensions between state and market authority that are internal to their political cultures of economic governance.

This co-production of ethanol statecraft and political culture is best observed by comparing state strategies for developing cellulosic ethanol after the Global Recession of 2008. Both Brazil and the US have funneled significant resources to realize the nation's imagined cellulosic future, including funding cellulosic research, development, and commercialization projects. Such activities are carried out in national laboratories and industrial pilot plants working to bring advances in biotechnology and process engineering to economies of scale. These technologies promise to enable higher-yielding biomass production systems that transform a wide range of cellulosic feedstocks into biofuels, including corn stover, sugarcane bagasse, municipal solid waste, forest residues, and dedicated energy crops like switchgrass and miscanthus. Whereas first generation ethanol production systems use relatively simple, well-established processes to convert corn or sugarcane to fuel, cellulosic systems have required further innovation to bring down conversion costs during industrial processing. Scaling cellulosic ethanol production to commercial levels may necessitate the reorganization of entrenched supply chain relationships to integrate new feedstocks into existing production systems.

In Brazil, the state's cellulosic vision focuses on expanding sugarcane production without increasing deforestation through new crop technologies that will allow sugarcane-ethanol producers to capture profit from not only from ethanol production, but also from ecosystem services. Government funding supports research into new breeds of drought-tolerant sugarcane, engineered to produce more cellulosic material in each stalk and to breakdown easily during processing at Brazilian cellulosic ethanol mills. In contrast, the US cellulosic ethanol imaginary involves a new landscape of bio-refineries that compete with petroleum refineries. New cellulosic crops, farming practices, and conversion technologies that provide a platform for bio-based industrial complexes that will not only pump out ethanol, but also industrial chemicals, other liquid fuels, food products, and non-food materials. In both countries, cellulosic ethanol imaginaries portray a shift in land use patterns. US policymakers envision building cellulosic supply chains rooted in native grasses grown as monocultures. The Brazilian state imagines

transforming the Cerrado landscape into a sugarcane-forest, whereby cellulosic sugarcane crops are grown interspersed with native flora. These landscape changes will require new growing and harvesting methods, new production and distribution infrastructure, and new governing mechanisms to address potential risks to communities and the environment.

These cellulosic imaginaries also speak to the political cultures from which they emerged. In the US, industry experts argue that investment in commercial-scale production remains the biggest barrier to expanding cellulosic production systems in the US. Ethanol imaginaries have attempted to show how state can support the commercialization of cellulosic ethanol without undermining an economic governance tradition that prohibits "picking winners." In Brazil, cellulosic imaginaries reference dependencies on international research consortia and foreign investment. Yet they also expressly position Brazilian researchers and technologists as representatives of the state who can ensure international partnerships do not undermine the nation's ability to become a provider of science and technology (as opposed to simply a raw material producer). Both case studies situate these envisioned strategies at the tail end of ongoing ethanol development trajectories, rooted in different state ideologies and traditions about economic governance.

In the three chapters that follow, I construct a critical "history of the present" that links together a contemporary analysis of ethanol policy with a historical analysis of each nation's evolving political culture of economic governance.[49] Each country-specific genealogy shows how the contemporary goals, practices, and institutions of ethanol policymaking have emerged from historical struggles about economic governance. I highlight the major historical struggles over economic governance prompted by various political and economic crises. What ideologies have state actors invoked in order to solve crises? How have such ideologies generated new meanings, practices, and strategies for developing, funding, organizing, and regulating economic life? Which strategies of economic governance have endured or strengthened over time and can be regarded as "tradition" (cf. ideology, as per Swidler's conception of culture in action discussed above)? I then trace the history of government policies designed to support domestic ethanol industries to understand how states articulates the means-ends designations of ethanol policy; what ethanol-related end goals a nation's leaders believe are desirably; what risks and benefits are expected to materialize in said ethanol future, and; what strategies of action and concomitant policy tools are deemed appropriate to get there.

[49] The aim of a genealogy is to construct a critical "history of the present" derived from historical methods that identify the forces, power relations, and processes have brought some present day phenomenon into being (Foucault, 1991). Unlike Foucault's earlier method of archaeology, the point of genealogy is to trace the process whereby the past became the present. As Garland (2014) argues, Foucault's notion of genealogy as a history of the present must be understand in the context of an explicit shift in Foucault's research from "archaeology" to "genealogy." His turn to genealogy and the history of the present came late in his career, beginning with *Discipline and Punish* (1979). Whereas his method of archaeology aimed to reveals structural order, genealogy reveals the ontology of ourselves and of our present reality. Both involve critical historical analysis, but whereas his archeological analysis was meant to connect present day phenomenon with its origins in structural order, his genealogical analysis was concerned with determining the conditions of possibility in modern times.

Chapter 3 Political cultures of economic governance in the US

How has political culture of economic governance evolved in the US? Existing scholarship has highlighted different aspects of US political. Some researchers define US political culture as an ongoing, unresolved conflict between the values of freedom and equality (Lipset 1979; Feldman and Zaller, 1992). Brown (2006) elaborates on this tension arguing that contemporary American political culture is the product of two forces: the political rationality of neoliberalism and the moral rationality of neoconservatism. Such works provide important insights but deal less explicitly with how US political culture manifests more narrowly in a state's conduct in economic governance.

To answer this question, I trace the founding ideologies of economic governance that emerged during the US's formation as a nation state and the subsequent developments of traditions of economic governance over major historical struggles prompted by political and economic crises. As discussed in the previous chapter, this genealogical analysis seeks to identify the ideologies that state actors have turned to in moments of crises, and to delineate how those ideologies have or have not generated new meanings, practices, and strategies for developing, funding, organizing, and regulating economic life.

Moreover, my analysis pays close attention to the interaction between ideology and tradition to identify which strategies of economic governance have endured or strengthened over time. The genealogical analysis shows that ideologies and tradition develop iteratively, building upon one another. At certain times, state actors use ideology to challenge older traditions with new practices and strategies. At other times, they repurpose older traditions in order to implement new ideologies. The contemporary political culture of economic governance in the US can be understood as the amalgamation of a succession of changes to ruling ideologies and tradition.

In this chapter, I argue that ideologies and traditions of economic governance in the US have evolved around a fundamental paradox that began with the nation's founding. The founding voluntarist ideology of American colonists accounts for the overall weakness of the US state in economic governance, as well as the strength of American capitalism, which repeatedly demands stronger state involvement in economic life. US political culture has evolved around this paradox, creating dueling logics about how the state should exert its authority over the economy and how the economy is understood to undermine the need for state authority. The logic of economic efficiency holds that the creativity of, and competition between, market actors generates the most socially desirable outcomes, while the logic of technocratic planning asks the state to play the role of an expert that engineers the economy to direct economic development and sociotechnical change towards nationally desirable outcomes. The tension between these two logics runs through US history, expressing itself differently at different historical junctures in US political cultural traditions and ideologies.

Over the last few decades, the tension can be best seen in debates about industrial policy. The most recent manifestation of political culture from this struggle has been an adherence to the discourse of government not "picking winners" in order to let a "thousand flowers bloom." This metaphor has translated into a responsive position on the part of the US state, in which state

actors looks to the initiatives of entrepreneurs and large firms to bring imagined sociotechnical change to fruition through the efficiency of market competition. At the same time, the US state exerts its "hidden" capabilities in economic development to support private sector initiatives, for instance by repurposing its capacities in defense contracting and performance-based regulation to steer market actors. US political culture continues to evolve with efforts to resolve these fundamental tensions. In 2013 the Wall Street Journal asked a group of international industry leaders and policy experts to debate the question, "Should the government finance new-energy technologies?" The answers varied. There were measured endorsements for "temporary but strategic" public financing for green innovation; strict calls for market mechanisms to price carbon, and; outright "No's," cautioning that politicians fundamentally cannot be trusted "to make decisions about economic growth or the environment" (Wall Street Journal, 2013).

3.1 The Ideology of Voluntarism in the Revolutionary Era

According to sociologist Claude Fischer (2010), the ideology of voluntarism that ascended during eighteenth century Revolutionary America embodied a set of beliefs and behaviors based in two assumptions. First, every free man is a sovereign individual with the independent competencies and virtues required to be self-reliant, maintain property, and support a household. Second, the success of the individual depends on having the freedom to choose his fellowships and form voluntary communities.[50] The roots of voluntarism can be traced to the moral and political philosophy of the eighteenth century Scottish Enlightenment, especially that of Adam Smith, which had been extremely influential in colonial America (Hovenkamp, 1991). Philosophers of the "Scottish Approach" shared a strong commitment to the notion that individuals possessed "common sense"—the innate ability to judge reality, to discern right action from wrong action, and to determine one's own religious, ethical, or economic decisions.[51] The notion of common sense opened up new possibilities for a shared empirical truth among members of a society and reinforced a philosophy of science that relied less on hypothetical cases and more on inductive, experimental methods for interpreting observations (Comin, 2002). One important implication of common sense was that ordinary people did not need the authoritative guidance of government officials and experts (Comin, 2002).

Adam Smith translated the ideology of voluntarism into principles of political economy for the emergent liberal state. In The Theory of Moral Sentiments (1759), Smith argued that the existence of common sense implied individuals possessed the self-reliance and voluntary association needed to make moral decisions in economic life whereas large, government-

[50] More specifically, Fischer (2010) explains that voluntarism has two key elements. The first element of voluntarism is believing and behaving as if each person is a sovereign individual, having the independent competency and virtue required to maintain property and support a household. The second element of voluntarism is believing and behaving as if individuals succeed through fellowship—not in egoistic isolation but in sustaining voluntary communities.

[51] Hovenkamp (1991) and Comin (2002) explain that although Scottish intellectuals of this movement shared a belief in common sense, their moral and political philosophies differed. Smith's theory directly countered the positivism of David Hume. Hume held that because the world is infinitely unknowable, human knowledge is forever limited, and therefore rather than absolute moral certainty, we can only know an action is wrong only if authoritative power says its wrong. Fifty years later, many of these ideas reappeared in the influential writings of Francis Wayland, a famed political economist of the Jacksonian period.

sanctioned capitalist entities, like the East India Company, did not; the morality of corporate monopolies was inherently compromised (Hovenkamp, 1991, p. 74-6).[52] Smith argued forcefully for the development of liberal state, whose capacities could ensure the creation and functioning of small, local markets under the moral and political leadership of local business people (Muthu, 2008). As he laid out in The Wealth of Nations (1776), the key functions of the liberal state were to protect individuals from undesired sources of despotic power and facilitate the release of individuals' creative entrepreneurial energies (Hovenkamp, 1991).

Thus, the ideology of voluntarism provided the foundation for a tradition of laissez-faire economic governance to emerge in the 19th century.[53] American colonists understood communal responsibility, self-reliance, individual self-determination, and freedom of association to be the antidote to the kind of concentration of power that had amassed in the church and state under British rule. They firmly believed that overly concentrated power was source of despotism and the principal threat to their religiously motivated pursuit of liberty, individualism, and egalitarianism. They enshrined community sovereignty in the Constitution through a separation of powers that allocated political and economic power to the lowest level possible. This gave way to a passive federal superstructure while enabling a series of autonomous community governments to thrive. Although the federal government maintained some central power through its courts, stronger governing capabilities amassed in state and local governments. Localities controlled their own schools, courts, public works, and legislatures (Dobbin 1994, p. 41-43).

3.2 The Laissez-faire Tradition

The laissez faire tradition of economic governance took shape in early and mid-nineteenth century America. This tradition embodied the ideology of voluntarism. It defined the boundaries of government intervention around the need to create conditions for entrepreneurial creativity and free exchange among private citizens. The principal functions of government intervention in economic affairs consisted of (i) a legal framework to maintain property rights as

[52] Smith posited that the "moral sense" of individuals enabled each person to discover moral laws and, with an awareness of moral laws, they had the capability to choose right action when confronted with an ethical dilemma. For Smith, choosing right action in economic affairs was an issue of morality.

[53] Scholars offer many different characterizations of the initial ideology of 18th and 19th century America as individualistic. Lipset (1996) describes American ideology in five words: "liberty, egalitarianism, individualism, populism, and laissez-faire" (31). Greene hones identifies successive ideologies of individualism in US political history (2008). He argues that the first of these was an "ideology of self-willed success" that emerged during the post Civil War reconstruction period as a means of unifying American culture. By contrast, Shain (1994) argues that conceptions of individualism as ideology are overly general and fail to account for Revolutionary-era Americans' New England townships, religious communalism, and communally based political ethic, in which both the individual and communal good was realized through the shared pursuit of local autonomy and protection of the right to self-determination. Similarly, sociologist Claude Fischer (2010) challenges the notions that America's founding ideology was individualism, which he defines as "the principle that gives priority to the individual over the group or institution." Instead, Fischer uses the term "voluntarism" to capture *both* individualism and communalism in early American ideology. Dobbin (1994, p. 36-7) similarly argues that American society prioritized community sovereignty and individual creativity. My aim here is not to survey the differences of these ideologies, but to explain Fischer's concept of "voluntarism" as a more accurate and useful description of initial ideological development in 18th century American political culture. I then argue in this section that voluntarism led to the Liberal State's laissez faire developmental tradition in the early 19th century.

a precondition for competition between economic actors and (ii) the provisioning of public resources—primarily land—to facilitate the creative productivity of individuals.

Initially, the growing availability of private capital undermined the need for public capital and resource provisioning (Lipset 1996; Dobbin, 1994). American businessmen and politicians of this era looked primarily to the state for economic governance in the form of the protection of their individual liberties. The scope of such protection included upholding free importation and exportation and enforcing the legacy of European Lockean property rights. In practice, this fell to the courts, which enforced the individual's right to profits earned from property and contracts between private parties (Holmes, 1995).

However, as the 19th century progressed, in order to empower individuals' creative economic pursuits, the Laissez-faire tradition expanded to include the provisioning of resources. The ideology of voluntarism had promoted economic governance by local business leaders. At the community and state levels, local governments were empowered to act in the interest of their constituents (Dobbin, 1994, p. 39-41). During the Jacksonian era (1829–37), local governments saw the promotion of economic growth as their natural duty and did not equate the actions of town meetings and state legislatures with uninvited meddling associated with the rebuffed colonial regime. Political leaders including Alexander Hamilton and President John Quincy Adams (1825-1829) justified resource provisioning as a core state function justified by notions of state sovereignty over the American economy and the moral obligation to ensure that economic progress benefitted all. As Adams argued in his state of the union address:

> The great object of the institution of civil government is the improvement of the condition of those who are parties to the social compact, and no government, in whatever form constituted, can accomplish the lawful ends of its institution but in proportion as it improves the conditions of those over whom it is established. Roads and canals, by multiplying and facilitating the communications and intercourse between distant regions and multitudes of men, are among the most important means of improvement…For the fulfillment of those duties governments are invested with power, and to the attainment of the end – the progressive improvement of the condition of the governed – the exercise of delegated powers is a duty as sacred and indispensable as the usurpation of powers not granted is criminal and odious. (quoted in Dobbin 1994, p. 43).

John Stuart Mill also argued famously in his popular book Principles of Political Economy (1848) that the provisioning of resources was among the "necessary" functions of government. Legal theorist James Hurst (1956) has argued, nineteenth century law and economic development co-evolved such that government aid could help men realize their creative energy in the realm of the economy. Judges and politicians increasingly "interfered" in economic life to ensure individuals' creative energies were not constrained in the presence of unclaimed natural abundance and man's new technical command of nature (Hurst, 1956, p. 5-9).[54]

Resource provisioning carried out at the state level created new capacities at the federal level as well. The federal government transferred loan guarantees and land grants to state governments, which then administered land to private actors for improvements in wagon roads,

[54] In his economic history of early nineteenth century America, Hurst describes a widespread belief in human nature as resting "largely in the expression of its creative capacity" and the "meaning of life" as resting in individual "choices as to what they do and how they are affected by circumstances.

canals and rivers. Aside from this, the federal superstructure was a relatively passive economic actor, with the exception of the judiciary, which intervened to enforce contracts between private economic actors (Dobbin, 1994; Hurst, 1959). By comparison, the population of decentralized, autonomous community governments developed fiscal capabilities to grow their local economies.[55] State and local governments raised money, issued bonds, generated revenues, administered eminent domain, oversaw the creation of limited liability corporations, made direct loans, initiate public ventures, allowed monopolies, and even commanded banks to make private loans (Lipset 1979).

Local capacities emerged notably in railroad development. States provided massive direct act to private railroad interests and weighed in on the railroads' route planning. There was some enthusiasm for even greater federal aid and planning in the economy, but railroad boosters in the 1830s preferred the subnational level. Subnational governments in Philadelphia, Baltimore, Massachusetts and Ohio led the way by working with business actors to support early railroad projects in their own jurisdictions.[56] Americans viewed state intervention in railroad development at the state and local levels as an appropriate exercise of governmental powers and a necessary duty of government.

However, railroad development soon inspired even greater federal activism, as it became clear that subnational governments were unable to coordinate interstate planning. Subnational governments lacked the oversight capabilities to address corruption among local officials who were drawn to graft and the administrative capacities needed to coordinate public works projects across state lines (Dobbin, 1994).[57] Railroad interests turned to the federal government for help. In its response, the federal government bypassed state governments altogether, providing an unprecedented level of wholesale land grants directly to railroad companies between 1850-1871. This move temporarily gave the federal government greater influence over route and infrastructure planning and helped to attract additional private investment.[58]

Yet this two-decade stint in federal railroad development ended with greater distrust in federal activism in economic development. As railroads grew in size and became more

[55] In town meetings and state legislatures, Americans did not question whether local government should have direct involvement in economic life (Dobbin 1994, p. 28-29). Community sovereignty prevailed over schools, courts, and legislatures, and local economic development (Dobbin 1994, p. 41-43).

[56] This reflect the earlier industrial order in the US, whereby subnational governments actively exercised sovereignty over the economy (Dobbin 1994, p. 42).

[57] Graft between local officials and local entrepreneurs became a rampant problem. For example, Dobbin (1994) shows how subnational governments in Philadelphia, Baltimore, Massachusetts and Ohio led the way in local railroad development by working with railroad boosters in their own jurisdictions, but these efforts ultimately failed due to poor oversight of sub-national government officials who were drawn to graft. At this time, the US lacked professionalized public service. Public officials were appointed politically as amateur volunteers until the 20th century. In contrast to other countries, office-holders held tenure based on publicly-relevant expertise, such as civil engineering, accounting and administration (Dobbin, 1994, p. 59)

[58] Before 1841, the federal government had only made land grants only to state governments. President Lincoln signed the Pacific Railroad Bill, which chartered a California-based and Nebraska-based railroad company to build a route from Omaha to Sacramento with the aid of land grants and federal loan guarantees. Despite some opposition from those who questioned the authority of Congress to aid development through land grants, bill supporters won on the grounds that the federal government would quickly recoup the costs through savings that railways would create in conveying mail and supporting military operations (Dobbin 1994, p. 53).

economically powerful, they took over railway development from the federal government (Dobbin 1994, p. 59). With the more public land in their possession, railroad companies successfully lobbied against federal intervention, citing a number of controversies in which government officials were found to commit graft and investor fraud validated the critique of big government as a despotic, centralized power.[59] Despite the unprecedented growth achieved by direct provisioning to railroad companies, the federal government's intervention in railroad planning reinforced a widespread belief that strong central political powers could not be trusted to administer economic affairs (Dobbin 1994, p. 54-56).

3.3 The Ideology of Economic Natural Selection

A new ideology emerged in the last quarter of the nineteenth century with the "big merger movement." The period between the 1870s and the 1910s witnessed deep changes in American capitalism. With industrialization and economic prosperity in the years after the Civil War, great wealth to amassed in the hands of private individuals and private sector economic power grew unchecked. A drive towards greater concentration of economic power and corporate capitalism gave way to oligopolistic industries. Cartels formed and engaged in competitive pricing wars, constituting the kind of despotic concentration of power that the Constitution had intended to prevent.

At the same time, Charles Darwin's Origin of the Species theory began to gain traction in intellectual circles in the US and Britain (albeit amid bitter controversy). His theory of natural selection influenced thinking on subjects beyond the study of nature.[60] Neoclassical economic theory incorporated these ideas, arguing that competition in economics was a natural extension of "the survival of the fittest" (Fine, 1978: 100). As applied to economics, the survival of the fittest doctrine suggested that economic life was part of the underlying natural order and natural selection meant that large entities were inevitable. Neoclassical economics and social Darwinism justified inequality as a natural outcome of competition. The accumulation of wealth was understood to be "de facto proof of evolutionary superiority, whereas poverty was believed to be

[59] In 1872, after a congressional investigation into the matter, Congress promised no further land grants would be made to railroad companies.

[60] I use the term "economic natural selection" to refer to an emergent view of market forces as something natural and inevitable, that needed to be balanced. Although the publication of Charles Darwin's *Origin of the Species* in 1859 ignited bitter scientific controversy about the validity of competing evolutionary theories, especially among Christian men, by the 1870s, Darwin's "survival of the fittest" doctrine had become widely accepted (Mayr, 1991). Although I cannot find any primary sources that apply the metaphor to the economy at this time in history. Since then, there have since been numerous of cases of applying biological evolutionary theories to the study of economic behavior, including Nelson and Winter's (1982) *An evolutionary Theory of Economic Change*, and Oded Galor and Omer Moav's (2001) *Natural Selection and the Origin of Economic Growth*. The concept of natural selection can be adopted differently for economic phenomenon. For example, taken in two different senses, which correspond to two general conceptions of the principle of natural selection (e.g. reproduction, growth, heredity), the metaphor has been used to claim that the "survival of the fittest" in the economic sphere are firms that the best profit maximizers. From this view, a process of natural selection occurs when the firms that fail to conform to the profit maximization principle are eliminated from the economy. By contrast, Nelson and Winter (1982) analogize economic natural selection to genetic natural selection, whereby firms' routines determine their survival or extinction. See Gayon (2012) for more discussion on Nelson and Winter's various approaches to conceptualizing economic natural selection. For a summary of critiques of biological analogies in economics, see Hodgson (2002) "Darwinism in economics: from analogy to ontology."

evidence of evolutionary inferiority" (Hunt, 2003, p. 129-130). Social Darwinists argued that some level of inequality was inevitable and therefore a natural part of industrial development (Leonard, 2009; 2011). This logic justified the growing class disparities as a natural outcome of competition. Poverty was acceptable because of some men's natural tendencies toward weakness, imbecility, laziness and worthlessness (Fine, 1978, p. 98). Workers were part of a hierarchy that included a managerial class and an increasingly absentee capitalist class.[61]

Yet the emergence of trusts and monopolies in all major parts of the economy had been the direct result of the federal government's laissez faire tradition. The federal courts had played a significant role in the merger movement through their enforcement of the Fourteenth Amendment. The railroads and most other industries had been relatively atomistic up through the Civil War years (1861-1865). This began to change with the ratification of the Fourteenth Amendment, which applied not only to freed slaves but also to shareholders seeking protections against state regulation. Court rulings on Fourteenth Amendment cases invalidated state legislation that attempted to curb the accumulation of economic power. For example, in Santa Clara County v. Southern Pacific Railroad, 118 US 394 (1886), the U.S. Supreme Court upheld the rights of shareholders or anyone to form corporations without any particular government authorization, which had previously been granted by state legislatures. As a result, corporate organizations grew internally, by acquiring competitors, and by destroying the viability of smaller competitors. A wave of mergers and acquisitions occurred at an unprecedented in the last quarter of the nineteenth century, and by the turn of the century the industrial revolution was dominated by corporate monopolies (Hunt, 2003).

Federal direct provisioning had also enabled the formation of cartels. This was perhaps most apparent in the railroad sector (Dobbin, 1994). The railroad companies acquired huge tracts of land alongside their tracks through the unprecedented level of loan guarantees and wholesale land grants made by the US government directly to railroad companies between 1850-1871. Railroads then sold this land in order to recover their construction costs. Their landowning status enabled significant economic power. Federal provisioning enabled the formation of over twenty private railroad associations.

Although many believed large powerful firms were capable of exercising their power for the greater good of society, the formation of cartels and trusts ushered in a form of competition that many saw as cannibalistic for industry and destructive of the public interest. For example, the large agricultural combines that formed in the 1880s threatened to drive down the prices of independent railway entrepreneurs, famers, shippers and manufacturers. Pricing wars between railroad cartels were especially cannibalistic and seen as a menace to democracy and the public interest.[62] The monopoly power of cartels threatened to halt railroad functioning by setting unfair prices, leading farmers, shippers and manufacturers to organize against monopoly power as a direct threat to their economic liberty (Fligstein, 1990).

[61] In working-class communities, an individual's social esteem increasingly depended on whether they possessed as much property and material goods as others in their community. This cultural discipline reinforced the idea of economic natural selection among the working class by distinguishing those worthy of uplift from those not, namely people considered too poor, unskilled or undisciplined to contribute to society's economic health and well-being (Leonard, 2009).

[62] The first railroad cartels emerged in the 1880s, formed by railway entrepreneurs who had come to believe that their survival depended on setting competitors' prices (Fligstein, 1990).

Under the ideology of economic natural selection, destructive pricing wars called into question the viability of the US tradition of laissez faire economic governance, especially the abilities of sub-national governments. The 'big merger movement' rendered sub-national governments virtually powerless to large corporations (Hunt, 2003, p. 121). There was widespread agreement among American businessmen and politicians that some form of limited government supervision was needed to address the problem of monopoly power (Hunt, 2003, p. 154-155). However, subnational governments were ill-equipped to respond. For example, the state-level Granger Commissions attempted to put a stop to railroads' price discrimination. These commissioned organized a strong network of state-level farmer-based coalitions to check the power of railroads by setting and enforcing maximum rates. Ultimately, the Granger Commissions failed to gain political traction under criticism that they lacked the technical expertise and jurisdictional powers needed to regulate interstate prices.[63] The public policy pendulum began to swing away from state-level leadership over economic development.

Businessmen themselves were the leading advocates of establishing federal institutions to curb the destructive competition between huge trusts and cartels. Even the large railroads wanted greater federal involvement, despite their previous opposition to federal intervention. Many businessmen defended US capitalism's mass production and corporate concentrations of wealth, but increasingly saw monopoly power as undermining their interests, given the destructive wave of pricing wars (Hunt, 2003, p. 130). Oligopolistic industries began turning to the government for help as they found themselves unable to cooperate with one another to advance their shared interests (Hunt, 2003). The general public and many defenders of capitalism believed these concentrations of economic power threatened their traditional economic liberties.

Beyond the industrial and business elite, mainstream public sentiment expressed a desire for more state intervention (Hunt, 2003). Prices rose for those who were not part of the new capitalist class, demonstrating that self-determination depended not only on freedom from despotic political forces, but also on freedom from despotic economic forces (Hunt, 2003). Growing inequality shifted the public distrust of centralized power beyond the political realm and into the economic realm. Americans saw monopoly power as a great threat to the individual's right to self-determination and equality among men (Dobbin, 1994).

3.4 The tradition of Refereed Competition

Public support grew for federal authority that could discipline new concentrations of economic power. In response, two new traditions of economic governance emerged under the

[63] The Granger Commissions were hamstrung by public distrust for government-employed technocrats and a lack of expertise about the operations of giant corporations whose track infrastructure crossed state boundaries. Governors could not recruit experienced railway men because of strong anti-railroad sentiment. Railroads argued that the lack of expertise made the Grangers' a small, inexperienced set of state agencies that set illogical rates (Dobbin 1994, p. 72-73). At this time, the US lacked professionalized public service beyond that of the Army Corp of Engineers, which was characterized by infighting and viewed with suspicion as a kind of political elite (Porter, 1995, p. 148-9). Public officials were appointed politically as amateur volunteers until the early 20th century. In contrast to other countries, like France, office-holders held tenure based on publicly-relevant expertise, such as civil engineering, accounting and administration (Dobbin, 1994, p. 59).

ideology of economic natural selection: Refereed Competition and Scientific Managerialism. Whereas the former entailed creating fair rules of competition, the latter sought apply the tools of scientific management to achieve efficiency as a form of fairness in the economy. Through fair competition and organizational efficiency, large firms would be capable of achieving growth alongside contributing to social progress. New regulatory forms emerged designed to aid the natural selection of firms in free markets as the mainspring of growth. Sklar (1988) describes this period of US history and what is commonly called the Progressive Era, as "both an age of reform and the age of the corporate reconstruction of American capitalism."

The ideology of economic natural selection naturalized competition between firm and economic inequality, but not monopoly power (Fligstein, 1990). Monopoly power had proven disruptive to fair competition, upsetting the market's self-regulating capability. Neoclassical economists maintained that government should not interfere because unbridled competition among free firms was the most rational and efficient way to achieve progress in the economy. They believed market actors were sufficiently capable and powerful to influence the market without government interference. Yet even their vision of a self-regulating economy comprised of atomistic industries in which firms of equal size competed on fair terms implied the presence of a regulating force that could maintain conditions needed to enable an economy comprised of a large number of small producers. The "survival of the fittest" doctrine required that "the fittest" not be so fit as to undermine the flourishing of competition between small firms. The ideology of economic natural selection depended on an entity that could provide the conditions needed to harness the capabilities of large firms without destructive competition.

In the tradition of refereed competition, the state played the role of a disinterested umpire overseeing competition between economic actors by setting and enforcing ground rules, without impeding the overall direction of growth pursued by corporations.[64] No previous laws had attempted to affect competition among firms or within a sector (Dobbin, 1994, p. 65). Policy proposals such as those made by the influential economist Henry Carter Adams advocated for federal intervention focused on setting and enforcing ground rules for business activity (Dobbin, 1944, p. 57). Such proposals centered on the need to simultaneously encourage entrepreneurial competition and fair competition without allowing the federal government to become an activist state. Society, not the state, would shape the overall direction of the economic development and growth. The leaders of the Progressive Era sought way to check large concentrations of economic power without slowing America's exceptional industrialization through large, efficient corporations.

In practice, this tradition entailed state supervision of economic competition through the creation of both sector-specific and economy-wide "ground rules." The first sector-specific federal regulatory agency emerged in the railroad sector under the Interstate Commerce Act of 1887 (ICA), which created the Interstate Commerce Commission (ICC) to protect the economic liberties of railway customers and railway entrepreneurs by eliminating price-fixing and rate discrimination. The Sherman Antitrust Act of 1890 followed, making cartels illegal. Both

[64] This metaphor is also explored by Duquette, Jerold J. 1999, *Regulating the National Pastime: Baseball and Antitrust*, Praeger Publishers: Westport, CT.

regulatory forms eventually expanded into all major sectors of the US economy.[65] Institutions for refereed competition quickly spread to other areas of the economy. Anti-trust law became a central tool for structuring entire industries like the oil industry and telecommunications, and regulatory agencies modeled after the ICC oversaw pricing and competition for industries such as electricity, natural gas, radio, television and aviation (Dobbin, 1994:3). In addition, new sector specific laws were passed to facilitate fair business practices. For example, the Cotton Futures Act of 1914 and the Grain Standards Act of 1916 authorized the United States Department of Agriculture (USDA) to issue physical standards for commodities to minimize speculation in agricultural markets. These laws helped to reinstate the conditions needed to restore fair competition between firms (Hunt, 2003: 123-124),

The tradition of refereed competition also extended into social policy arenas, as part of the effort to make big business a force for good. President Theodore Roosevelt asserted that the intent behind anti-trust regulation was not to break up the large firms; the goal was to make big business "good," not to make it "small" (Leonard, 2015: 61). In the early years of the Progressive Era, policy makers advocated for reforms that would address not just economic problems but social ones as well. The US government developed a number of new regulatory functions designed to instill more distributive justice in the US economy. For example, under the Wilson Administration, Congress passed a number of laws to protect workers and consumers from unfair business practices: The La Follette Seaman's Act of 1915 increased passenger safety and working conditions for sailors on merchant ships; the Adamson Act of 1916 established the eight-hour day for railroad workers, and; the Keating-Owen Act of 1916 regulated interstate commerce for goods made by children. Although these and other laws did not address economic governance directly, they set ground rules for firm behavior that could be refereed by the state.

Although Progressives believed that government could be a tool for change, refereed competition was based on the fundamental assumption that large corporations were ultimately the best vehicles for economic and social progress. In the ideology of natural economic selection, the well-behaving corporation exemplified the "survival of the fittest" doctrine. Unlike trusts and cartels, Progressives viewed the corporate form as capable of advancing economic progress without abusing their pricing power or engaging in corruption. The "New Nationalism" of President Roosevelt (1901-1909), the vigorous trust-busting cases launched by the Administration of President William Taft (1909-1913), and the "New Freedom" of President Woodrow Wilson (1913-1921) all subordinated the capabilities of federal regulatory commissions and courts to corporations as vehicles for economic and social progress (Sklar, 1988).[66] Even progressive social reformers like Jane Adams, Jacob Riis, and Ida Tarbel, who believed that the problems that had amassed as America industrialized, such as poverty, violence, greed, racism, class warfare, could be best addressed by the public provision of good education and a safe living environment, also saw the ability to work in an efficient workplace to be a key ingredient for achieving their Progressive social agenda. As Americans increasingly looked to

[65] In the early 20th century, in the years following the establishment of the ICC, many federal regulatory agencies were created in the mold of the ICC (Dobbin, 1994: 28, 93; Hunt, 2003), including The Federal Reserve Board (1913), Federal Trade Commission (194), Federal Radio Commission (1927), Federal Power Commission (1930), Securities and Exchange Commission (1934), Federal Communications Commission (1934), and National Labor Relations Board (1935), and the Civil Aeronautics Board (CAB).

[66] There were, however, important differences between Roosevelt and Taft and Wilson, with the latter two standing against Roosevelt's brand of statism. See Sklar, 1988.

the large corporate enterprise as the vehicle of progressive problem solving for modern society, industrial giants re-organized themselves according to the corporate form (Sklar 1988, p. 418).

3.5 The tradition of Scientific Managerialism

A second tradition and related tradition developed alongside refereed competition: the tradition of Scientific Managerialism. Whereas the tradition of refereed competition extended federal authority over competition between firms, the tradition of Scientific Managerialism applied to create new distributive capacities (as opposed to regulatory). These capacities extended federal authority over the private sector's creative energy and helped further transfer power from the states to the federal level. Just as the direct provision capacities developed under Laissez Faire tradition in the 19th century sought to ensure the realization of individuals' creative energies in economic life, the mission of Scientific Managerialism aimed to help the private sector realize its creative energy in the increasingly global market through the provision of public resources, most notably, public expertise. A new cadre of expert civil servants emerged during the Progressive Era to carry out the practices of Scientific Managerialism. Scientific Managerialism did not supplant the earlier Laissez Faire tradition, but built upon it with complimentary practices.

The state capacities of Scientific Managerialism took their inspiration from the scientifically managed corporations that emerged during the US managerial revolution that took off at the turn of the century. The widespread implementation of Frederick Winslow Taylor's Principles of Scientific Management (1911) provided American corporations with a management model that enabled corporations to develop strategies for competitive advantage that were not based on potentially-destructive pricing strategies, but on the basis of efficiency. Scientific management gave corporations a way to compete on the basis of cost. Progressives understood efficiency to be synonymous with overall fair play between firms as well as in businesses' relationships with labor and the public (Leonard, 2015). Scientific management was essentially an engineering approach to rationalizing and standardizing a firm's systems, work processes, and tools of production. A new class of manager-engineers emerged to function as efficiency experts within corporations that solve technical problems as well as class struggles.[67]

Importantly, Taylor's scientific management proved to have applications beyond cost-reducing efficiency gains; it could also prompt innovations and inspire firms' creative energies. The railroad industry demonstrated that new expertise and managerial processes could generate creative solutions to the safety and coordination problems, such as standardizing track gauges, standardizing time zones for predictable interconnections, integrating diverse signaling standards to coordinate traffic, and setting safety standards for brakes and emergency cords (Dobbin 1994,

[67] This managerial class became increasingly instrumental for supervising workers and managing the continuous class struggle between workers and capitalists owners (Hunt, 2003, p. 160-165). Scientific management proved less successful in solving issues of central concern to the Progressive Movement's social reform agenda. Such issues could not be translated into technical problems to be solved through scientific management. "Taylorism" positioned the new class of managerial efficiency experts to mediate conflicts between workers and managers (Leonard 2009). Corporate Progressives presumed that the distributional inequities in the allocation of firms' surplus value could be re-configured as technical problems with engineering solutions (Leonard 2009).

p. 60-64).[68] Such innovations came from within industry, despite popular arguments for regulatory requirements for railway signals, mandatory braking technology, and traffic coordination to prevent the loss of life from railroad accidents and improve service. American businessmen and policy makers considered railroad safety to be a private matter solved by railroad companies competing for customers, in contrast to Europe where governments understood railroad safety and scheduling to be a public problem requiring governmental coordination.[69] The railroads' use of scientific management provided important evidence that private actors' entrepreneurial energies could be directed toward the public good (Chandler 1977, p. 138-141).[70]

With their faith in the utility of large organizations, the administrations of the Progressive Era applied the same principles of Taylorism to political action to render government an efficient, mission-driven business. Progressives were suspicious of concentrated economic power and supportive of individual liberties and private property rights, but they admired the efficiency and rationality achieved through scientific management. For this reason, they came to accept bigger firms as capable of contributing greater social purpose than small producers and famers (Rodgers, 1982: 124). Progressives' faith in the epistemic and moral authority of science and its experts offered the command and planning capabilities needed to achieve more efficiency, order, and fairness in society. Just as neutral scientific experts could increase the competitive advantage of a manufacturing plant through organizational efficiency, so too could neutral scientific experts improve the various social ills of unplanned industrial capitalism (Leonard, 2009: 124-125). Progressivism was the ideology of the managers and engineers who administered the large organizations, and by applying the same principles they could rationalize organizations to society as a whole (Shenhav, 1999).

The mission of Scientific Managerialism was not only to improve the efficiency of government for government's sake, but to help the private sector realize its creative energy in the realm of the economy. Just as the Laissez Faire tradition that emerged in the 19th century used direct provision to ensure the realization of individuals' creative energies, Scientific Managerialism answered the same distributives duties of government outlined by Adam Smith.

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[68] These included standardizing track gauges, standardizing time zones for predictable interconnections, integrating diverse signaling standards to coordinate traffic, and setting safety standards for brakes and emergency cords (Dobbin 1994, p. 60-64).

[69] Other governments in Europe (namely the British and French) addressed railroad safety publicly through mandated safety standards. In the US, firms tried to adopt signal standards and modern brakes 1884. These efforts fell short, and the public safety situation remained dire. In 1893, President Harrison signed the Railroad Safety Appliance Act requiring the use of brakes and automatic couplers (Dobbin, 1994). If well-informed customers exercised their preference for companies with the best safety records, railroad companies with a high incidence of bad accidents would naturally lose market share to companies that innovated to offer safer service (Dobbin 1994, p. 179).

[70] Chandler (1977) argues that scientific managers in the railroads emerged as an efficient response to the increasing scale and scope of American corporations, which included making improvements in public safety, and that the need for greater management spurred the US managerial revolution at the turn of the century. Shenhav (1999) disputes this evolutionary, functional view of management history by spotlighting the conflict between workers and employers. Shenhav argues that American engineers helped spur the managerial revolution by pushing new concepts of "systematization" between 1880 and the 1930s as a way to transform the power struggle between employers and workers into a technical matter.

However, unlike the political economic philosophy of Smith, this tradition aimed to unleash the creative capacities of corporations, not individuals.[71]

The distributive practices of Scientific Managerialism took on the form of fiscal policies, public works projects, and new public institutions in the banking and agricultural sectors that administered public resources to the nation's leading industries. Wilson's national reform legislation of 1913-1916 was the culmination of this approach (Sklar 1988, p. 422). New taxes on upper incomes, corporations, and estates increased public revenue, enabled the funding of public works projects and the provision of new kinds of resources. Fiscal policy measures increased public revenue, enabling the funding of public works projects as well as the training of industry-specific experts. For example, the Federal Aid Road Act of 1916 was the first federal highway funding legislation in the United States. Other public works projects sought to improve access to energy and water resources. For example, Progressives fought for massive, publicly funded power and electrification projects to serve electricity consumers rather than wait for similar developments in the private sector.

Fiscal policy also enabled the government to expand its expertise and develop new institutions that better suited the needs of corporate capitalism and smaller enterprises. For example, the Federal Reserve Act of 1913 created a new central banking system that helped provided new credit facilities for big and small firms. Tariffs became a more strategic tool for the federal government to help regulate which foreign producers had access to US markets and help US corporations counter abusive pricing practices in international markets. A number of new state capacities emerged in agriculture, including price support regulation, federal aid for agricultural extension and education, special banks and credit systems. For example, the Federal Farm Loan Act of 1916 established a federal farm loan board to increase credit to rural family farmers. The Wheat Price Guarantee Act was a 1919 bill passed by Congress that gave the government the power to regulate the price of wheat.

The tariff, tax, and banking reforms of this period all entailed a cadre of experts to develop scientific planning practices. To carry out these practices, a number of distinct cadres of experts emerged under the tradition of scientific managerialism—most notably, under the "new nationalism" of President Theodore Roosevelt (1901-1909) (Porter, 2003, p. 39). Public works projects were led by the Army Corps of Engineers, which expanded its military focus to provide public engineering, design and construction to major public works projects. Together with the Bureau of Reclamation (established in 1902), the Corp led federal hydroelectric dam-building projects. In agriculture, Progressive Era reformers increased the work of agricultural extension specialists to help farmers increase their output at lower costs using new production methods and technologies (Malczewski, 2013; Henke, 2013, p.13-15).[72]

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[71] For example, to the extent that corporations did engage in unfair practices Progressive Administrations targeted individuals as the source of unfair business practices and unreasonable restraints on trade, rather than corporations themselves. As President Wilson put it in 1912, "you won't break up their automobiles, but catch the men that do the job riding and see that these very useful and pleasant vehicles of our modern life are left for legitimate uses" (quoted in Sklar, 1988, p. 418).

[72] The 1914 Smith-Lever Act elevated the work of the nation's agricultural extension specialists who worked at federally subsidized, state-run experiment stations tied to land grant colleges since the 1880s. Government-sponsored agricultural science began with the foundation of the land-grant university system, following the Morrill Land-Grant College Act of 1862, which provided grants of land to states. States could use their profit from the land

Economists became the most powerful cadre of the Progressive State's technocracy. Once considered public intellectuals, economists acquired the new status of scientific experts as advisers of the Progressive State (Leonard 2009, p. 126-128).[73] During the First World War (WWI, 1914-1918), President Wilson (1913-1921) created the War Industries Board (WIB), which elevated economists to more influential positions in the federal government. The WIB applied the ideas of scientific management from organizational business studies to coordinate industrial production during wartime, when international trade declined (Leonard, 2009, p. 133-135). When concerns emerged about the potential for electricity shortages amid increased power consumption from the wartime economy, the WIB led major improvements in the electrical power industry, including financing giant power plants and interconnecting power stations and utilities—both publicly and privately owned. Such projects provided important infrastructure for major technological revolutions and helped fuel industrial growth during and after the war.[74] Outside of the WIB, many progressive economic reformers also advocated for public utilities and public power projects due to equity concerns about how electricity consumers would be hurt by rapacious private utilities (Brigham, 1998). In many ways, the work done by WIB inspired new ideas about statist political theory, and foreshadowed many of the New Deal policy proposals of the 1930s (Radford, 1996; Brigham, 1998).

The administrations of Presidents Roosevelt, Taft, and Wilson all sought not just to referee competition between firms, but also to create the conditions for firms to thrive through the tradition of Scientific Managerialism. These administrations pursued a range of new strategies discussed above, alongside Refereed Competition, as the former did not conflict with the practices of trust busting or commission-based regulatory oversight of monopolies. However, whereas the tradition of Refereed Competition sought to keep the primary authority in

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to create colleges that would train rural citizens in agriculture. Larger and wealthier growers advocated for a system of agricultural experiment stations based at land grant colleges under the Hatch Act of 1887. These growers were eager to use new methods and technologies to increase their yields, like fertilizers to improve soil conditions and more resilient crop varieties. Smaller growers were more skeptical. They saw the work of agricultural experiment stations as overly focused on increasing yields without consideration for local conditions of land, climate and farming culture. The work of these experiment stations did not align well with grower interests until the Progressive Era, when the "extension movement" stationed expert advisors in local farming communities with the expressed task of bringing new agricultural methods and technologies to rural populations for improved productivity. The 1914 Smith-Lever Act raised the status of these experts by bringing cooperative extension programs under the aegis of the Department of Agriculture (USDA). *See* Henke (2013, p. 25-28).

[73] Most progressive economic reformers, that is, were statists but not socialists. For the economic reformers of the Progressive Era, socialism was a broadly defined concept about the proper relationship between the individual and society. A socialist in American progressive parlance prioritized society as a whole above the individual and believed that others should too. Unlike their European counterparts, American progressives did not endorse any program that would undermine individual property rights. As Leonard (2009, p. 116) explains, "The non-Marxian aspect of the "German economics" behind American progressivism survived its transplantation to American soil: few American reformers seriously embraced extensive state ownership of the instruments of production, the heart of programmatic Continental socialism."

[74] Major revolutions took place in transportation, communications, and higher-speed machinery—all of which compressed time and space in a way that bound workers to mass production and the public to greater and greater consumption. A common catalyst for most of these advances was energy: commercially generated electricity for public consumption and business purposes, as well as the mass marketing of the gasoline-fueled internal combustion engine, which powered industrial and residential spaces in ways that supported manufacturing and farm enterprises (Nye, 2005; Hughes, 1993).

administering the market in private hands, subject to government oversight (Sklar, 1988: 423-424), the tradition of Scientific Managerialism expanded the state's authority over market administration.

3.6 The Ideology of Corporatism

The ideology of corporatism in the US context proposed the economy was composed of interest groups whose could reach a state of benign mutual influence on one another through negotiation, in contrast to a market economy that functions according to competition. As a system of governance that was popular in Europe and Latin American, corporatism had already taken a variety of forms (e.g. from authoritarianism to welfare statism) that invariably involved the state calling upon representatives of society's major interest groups (e.g. business, labor, farmers, military, religious groups, and more) to settle problems through joint agreement reached under state guidance (Wiarda, 1997). In the US, corporatism was commonly associated with fascism due to the dictatorial means that foreign corporatist regimes have used to suppress certain interest groups and the many failures of corporatist policies elsewhere (Wiarda, 1997). However, corporatism as an ideology of economic governance in the US proposed that the economy could be run more efficiently if the state incentivized the private sector (business and labor) to negotiate mutually beneficial solutions with little state activism. Instead, of managing interest group cooperation (as in other corporatist systems), the state would serve as a facilitator—an entity that calls together interest groups rather than forces solutions upon them as a manager.

In this sub-section, I detail the events that inspired a turn to corporatist ideology in the 1920s, culminating in the stock market crash of 1929. I then discuss state actors' experiments with corporatist strategies of economic governance at the start of 1930s, which attempted to repurpose the tradition of Scientific Managerialism under the ideology of Corporatism. It is worth noting here that the term corporatism has been plagued with ambiguity in academic debates. Despite its usage for multiple purposes, the common feature of corporatism as a theoretical concept include the presence of continuous and structured participation of interest organizations in the policy process, in which bargaining and concertation assume central importance, and the central role of the state in facilitating the concertation of interests (Molina and Rhodes, 2002).

American politics post-World War I (WWI) took on a decidedly pro-business attitude over the 1920s, which strengthened the ideology of natural selection. Political leaders of this ear rolled back the state capacities of Scientific Managerialism to focus on Refereed Competition. However, the events of the 1920s leading to the stock market crash of 1929 and the Great Depression ushered in the ideology of corporatism. New ideas of economic governance challenged the ideology of natural selection and the limits of Refereed Competition.

After the war, a pro-business attitude strengthened in American politics, and the Progressive State shrank back to a more limited tradition of Refereed Competition. The expertise that had developed for Scientific Managerialism had helped the American economy to grow tremendously, both before and throughout World War I, but had become the source of political battles over the appropriateness of "public authority" (Leonard 2009; 2011). Many pro-business interests and classical economists opposed the Progressive State's tradition of scientific planning.

In the post-war climate, these opponents worried that too much governmental intervention allow the state to be a central planner of the economy, which would threaten economic liberty. They sought to limit the role of the state to the tradition of refereed competition, in which the government does not act as an economic player in its own right but maintains the role of an umpire. These critiques sharpened in the post-war climate. Republican Senators pointed to Wilson's desire to ratify the Treaty of Versailles in 1919 in order to create the League of Nations as yet another expensive public endeavor that would undermine American interests. There was popular support for US participation in the League of Nations, but Senate voted against ratification in March 1920. Warren Harding subsequently ran for the Presidency on an anti-League platform and won.

Over the course of the 1920s, the Republican administrations attempted to dismantle the capacities of Scientific Managerialism. In 1928, Herbert Hoover announced that they had successfully "restored the Government to its position as an umpire instead of a player in the economic game" (Hoover, 1934). In contrast to their predecessors, they saw governmental interference in the form of worker and consumer protections to stifle individuals' creative capacities. Republicans sought to revive an older philosophy of free capitalistic enterprise, and emphasized individuals' ability to increase productivity and create wealth. In 1922, Hoover wrote the following on American individualism and the challenge to liberty:

> Our social, economic and intellectual progress is almost solely dependent upon the creative minds of those individuals with imaginative and administrative intelligence who create or who carry discoveries to widespread application…In truth, the vastly greater productivity of the world with actually less physical labor is due to the wider spread of their influence through the discovery of these facilities. And they can arise solely through the selection that comes from the free-running mills of competition. They must be free to rise from the mass; they must be given the attraction of premiums to effort. Leadership is the quality of the individual. It is the individual alone who can function in the world of intellect and in the field of leadership.

Republican administrations cut income taxes, reduced government spending abilities, and refused requests from industry for institutional reforms in the law on the principle that industry should reform itself voluntarily (Craft and Fearon, 2013). Upon entering office, President Warren Harding (1921–1923) promised to "strive for normalcy to reach stability" (Harding, 1921). President Coolidge (1923–1929) maintained that "the chief business of the American people [to be] business," (Coolidge, 1925). And, in his campaign for the presidency, Herbert Hoover committed to continue his predecessors' approach.

Despite persistent requests for federal aid from agricultural interests with strong political backing, the post-war 1920s American economy enjoyed the prosperity of a consumer boom driven by high productivity in the automobile and building sectors (Field, 2011). Economic indicators showed the American economy to be strong: low interest rates, high levels of investment, significant productivity advances, stable prices, full employment, tranquil labor relations, high wages, and high company profits all contributed to a buoyant optimism in the economy. This optimism fueled a stock market boom, which led to the Wall Street Crash in October 1929 (Field, 2011).[75]

[75] At the peak of this boom, share values on the Wall Street stock exchange increased dramatically. Concerns mounted quickly over the possibility that volatile stock market speculation could collapse the economy. Economists

With the crash of 1929, President Hoover (1929–1933) was forced to break with his predecessors and agree to government-led reforms. The Hoover Administration responded by guarding the value of the dollar, cutting spending, and enforcing antitrust law to uphold existing industrial organization (Dobbin, 1993). The depression worsened. Falling farm income was now creating social distress in the rural communities. Nearly a quarter of the labor force was unemployed with many of those unemployed for more than a year months (Craft and Fearon, 2013). A wave of bank failures swept the US and Britain, leaving credit markets in disarray.

The Great Depression challenged the ideology of natural selection and the limits of the state-as-referee. American businessmen and policy advisers interpreted the speculation leading up to the crash as evidence that natural economic selection had morphed into "economic cannibalism" (Dobbin, 1993). Business leaders and politicians questioned the doctrine of the survival of the fittest. In his campaign for the presidency, democrat Franklin Delano Roosevelt (FDR) promised greater government control over the economy. His campaign mobilized groups across traditional economic divides, appealing to commercial agricultural interests and tenant farmers and industrialists and labor. FDR won overwhelmingly in the general election of November 1932.

Buoyed by a new consensus among industrialists, agriculturalists, and labor for government intervention to restore the economy to its pre-depression performance, the FDR Administration (1933-1945) proposed to overhaul state-society relations. The goal of such an endeavor was to restore the conditions required for economic growth, strengthen worker protection, protect consumers, and improve coordination between industrial interests—all with as little state intervention as possible. Once in office, the administration strengthened its promise to help allocate income more equitably in the economy so that workers and poor farmers would make income gains relative to capitalists (Finegold and Skocpol, 1995).

Although many American policy makers, economists and businessmen now rejected the ideology of economic natural selection and its faith in unbridled competition between firms, the FDR Brain Trust was divided ideologically over whether the new system should embody "concentration and control" or "competition and conflict" (Barber 1996, p. 10). Those who advocated for the former sought to model an American version of state-sanctioned industrial corporatism after the Italian government, which appeared to be a reasonable solution to depression (Barber, 1996). Others felt this approach diverged too sharply from classical economics and the ideology of economic natural selection (Dobbin, 1993; Skocpol and Finegold 1982).[76] The architects of the New Deal compromised by settling on a corporatist system that

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at the Federal Reserve responded with a decision to raise the interest rate gradually as a tactic to gently deflate the Wall Street bubble. In theory, higher interest rate were expected to discourage speculation without punishing legitimate borrowers. In practice, speculation actually increased: the higher interest rates inspired high-risk individuals and corporate investors to lend to Wall Street, which appeared to be an attractive lending option. After a few months of poor returns on their investments, these non-bank investors panicked, leading to the Wall Street Crash in October 1929 (Field, 2011).

[76] In 1932, FDR succeeded in mobilizing farmers as an economic group and combining their support with that of workers and tenant farmers. By offering vague support for the McNary-Haugen proposal, Roosevelt secured the support of commercial agricultural interests, industrialists and labor to win overwhelmingly in the general election of 1932 (Finegold and Skocpol, 1995: 203).

would function with as little state intervention as possible. The New Deal architects aimed to continue the tradition of refereed competition (primarily through anti-trust enforcement and trade policy) and add new federal capabilities to help manage the conflicts between labor and capitalists and between capitalists and other capitalists without creating an activist state.

Congress passed two laws to implement a corporatist system of economic governance in 1933, but neither endured opposition from industry during implementation. Both the National Industrial Recovery Act (NIRA) of 1933 and the Agricultural Adjustment Act (AAA) of 1933 mandated the creation of new administrative bodies in the executive branch--the National Recovery Administration (NRA) and the Agricultural Adjustment Administration (AAA). The NRA and the AAA would have authority to shape prices and production levels in agriculture and industrial sectors in order to allocate income shares more equitably in the public interest (Skocpol and Finegold, 1982, p. 256). Corporate interests who opposed federal oversight of prices and production successfully pushed to overturn both laws.

NIRA initially had the support of industrial capitalists, but garnered opposition when it became clear that administration of the law would be challenging. In essence, NIRA proposed a cartelization scheme that would benefit industrial, labor, and consumer interests through greater market coordination.[77] The law mandated collaboration between industry and labor and between firms in the same industry. In order to keep government participation to a minimum, NIRA required these private actors to draft their own agreements to codify fixed prices, standards of fair competition, and wages. In designing this form of government-mandated self-regulation, policy makers assumed that industry and labor leaders would be willing to lead a state-sanctioned corporatist system (Dobbin, 1993). After the law passed, it became clear that non-government actors would need guidance from government in crafting sectoral agreements. The newly formed NRA scrambled to develop these administrative capabilities (Dobbin 1993).[78]

Anti-state rhetoric among pro-business interests accused the NRA of overstepping in its attempt to build supportive state structures. Meanwhile, the economy showed no signs of economic recovery. Industry leaders began to withdraw their support for NIRA, even those who stood to gain the most financially (Skocpol and Finegold, 1982, p. 267).[79] Legal action ensued, and the Supreme Court struck down a major clause of NIRA as unconstitutional in 1935. Although there was room to revise the NIRA cartelization program after this ruling, the FDR administration abandoned its ideas for a corporatist system (Dobbin 1993; Skocpol and Finegold, 1982).

The Agricultural Adjustment Act (AAA) of 1933 similarly sparked controversy. Well-organized agricultural interests accused the federal government of overstepping its authority,

[77] In 1933, FDR explained the goal of NIRA was to assure "a reasonable profit to industry and living wages for labor with the elimination of the piratical methods and practices which have not only harassed honest business but also contributed to the ills of labor" (Roosevelt, 1938).

[78] Dobbin (1993) argues that NIRA lacked supportive state structures, which made the policy ineffectual. Without any sign of renewed economic prosperity, industry leaders withdrew their support for NIRA. Legal action ensued, and the Supreme Court struck down a major clause of NIRA in 1935. Although there was room to revise the NIRA cartelization program after the Court's ruling, Roosevelt abandoned the idea, which had become unpopular.

[79] NIRA was written to provide workers with the institutional backing for collective organization without doing away with their subordinate position to industrial management (Finegold and Skocpol 1995: 20)

despite supporting FDR during his presidential campaign. FDF had campaigned on a promise to revive the McNary-Haugen bills that failed to pass during the previous administrations in order to win the support of commercial farmers (Finegold and Skocpol, 1995: 203).[80] The McNary-Haugen bills of the 1920s tried to establish a marketing broker within the executive branch in the tradition of Scientific Managerialism. Such a broker would have the expertise to act on behalf of domestic agricultural interests to secure higher prices in foreign markets for their surplus agricultural commodities. Specifically, the state-as-broker would connect domestic producers to foreign markets willing to buy surplus product and help to build new markets for domestic agricultural commodities. The Harding and Coolidge administrations repeatedly opposed a series of these bills on the basis that they constituted an overreach of government.

The AAA of 1933 expressed a corporatist vision that went beyond what was proposed in the McNary-Haugen bills, igniting opposition among large farming organizations and processes of agricultural products. The new bill gave government the authority to control farm production levels and prices. Farming interests had wanted governmental support in their marketing effort, but did not want a federal agency controlling their production levels (Finegold and Skocpol, 1995: 204-206). Despite this, agricultural experts from the USDA national cooperative extension network persuaded commercial farmers and processors to support the bill.[81] Extension specialists had influence with large growers and processors who relied on their services to increase yields. They had gained prominence under the many programs that emerged with Scientific Managerialism during the Progressive Era.

To implement the AAA of 1933, FDR pursued an approach that repurposed the tradition of Scientific Managerialism under the ideology of Corporatism. He appointed many high-level USDA extension specialists to run the newly created Agricultural Adjustment Administration (AAA) to carry out production control planning tasks.[82] USDA extension experts were uniquely

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[80] In the early 1920s, a Southern cotton producers and Midwestern corn producers banded together to lobby their representatives to form a “corn and cotton” coalition in Congress. Beginning in 1924, the corn and cotton coalition made multiple attempts to pass the McNary-Haugen Bill on behalf of major farm organizations (Finegold and Skocpol, 1995: 203). The McNary-Haugen bill proposed the creation of a federal corporation to purchase farm surplus at pre-World War I prices. Critics pointed out that this would only encourage farmers to continue increasing their acreage. The surplus problem would intensify. This federal corporation would either store the surplus until domestic demand improved or sell it overseas to world markets at the cheaper world price. To finance the program, farmers would be charged "equalization fees" in the event that there were financial losses from marketing the surpluses overseas.

[81] The plan was to give individual farmers an allotment of domestic consumption according to recent production levels. Farmers would receive the higher domestic price for their allotment. Their surplus would be sold for the lower world price. Farmers would have community-level decision-making power about whether to participate in the annual production control plan (Finegold and Skocpol, 1995:205-206). If the community decided to join, the law still enabled individual farmers to opt out of the plan and transfer allotment rights to other farmers. Even though the proposed AAA allowed individual farmers to opt out of the production control program, major agricultural groups adamantly opposed the idea of state control over their production in the form of planned scarcity. They worried that the state lacked the capabilities to be a strategic entrepreneur, capable of planning scarcity and marketing goods in their best interests. Instead, they insisted that the best role of the government would be to guarantee fixed prices paid to farmer and help farmers dump any remaining surplus on the world market, not to plan scarcity.

[82] FDR appointed George Peek, co-author of the McNary-Haugen Plan, as the first AAA administrator. Peek continued to advocate strategic marketing over production control. He was soon replaced by Chester A. Davis, a convert to the production-control approach. FDR made Peek special advisor to the president on foreign trade. See Finegold and Skocpol (1995: 204).

positioned to implement the AAA of 1933 (Henke, 2013). Extension specialists had insisted beginning in the 1920s that marketing agreements alone would not solve the surplus problem and that production controls would also be needed (Finegold and Skocpol, 1995). Thus, unlike the NIRA experience, the AAA was not hamstrung by a lack of administrative support and expertise.

AAA of 1933 was eventually undone when large growers and processors withdrew their support for production controls. Big agriculture fought the AAA's efforts to set production levels; they worried governmental authority over production would threaten their economic position globally. Instead, they pushed for minimum guaranteed prices equal to the cost of production, even though it was a less financially beneficial arrangement (Skocpol and Finegold, 1982). They also criticized the AAA's attempt to ensure benefits for the rural poor, tenants and sharecroppers (Skocpol and Finegold, 1982). They worried that by catering to the rural poor and limiting production, the government would threaten their economic position. As in the case of NIRA, industry opponents of the AAA brought the case to the Supreme Court, which declared the AAA of 1933 to be unconstitutional.

Subsequent efforts to reformulate the AAA of 1933 drew upon the economic tradition of Scientific Managerialism but toned down the corporatist intentions. The replacement policies entailed a set of strategies that would satisfy large domestic agricultural interests' desire for supportive conditions to help it thrive in foreign markets: minimal production restrictions and more subsidies to pay farmers for overproduction. The Agricultural Adjustment Act of 1938 gave farmers the minimum price supports they wanted for cotton, corn and wheat; created systems for dealing with over and under production (including surplus dumping), and; enabled landlords to appropriate the subsidies directed to the rural poor. The law created the Federal Crop Insurance Corporation (FCIC) to cover wheat crop losses due to unavoidable causes, the Surplus Reserve Loan Corporation to assist farmers in the event of surplus, and the Commodity Credit Corporation to provide a minimum income to farmers and absorb their losses if crop prices fell below the value of a loan.83 These laws served the interests of large, successful well-managed farming and processing operations in the South and Midwest, who constitute the powerful "cotton-corn coalition" in Congress.84 Tenants and sharecroppers became landless agricultural laborers (Finegold and Skocpol, 1995: 207).

Other replacement policies extended public authority over agriculture using Scientific Managerialism. The Soil Conservation Act of 1936 reformulated production control as land use and soil conservation programs that restrict the land available for farming. This law had the added effect of positioning the work of land grant colleges and agricultural experimental stations to be of even more value to farmers by providing technology-based strategies for increasing yields through innovative cultivation methods rather than by acquiring new land. Farmers benefited from their close ties to USDA extension specialists.

[83] If prices fell below the value of the loan the farmer could surrender the crop to the Corporation, which would absorb the loss and let the farmer keep a minimum income. If prices rose above the value of the loan, farmers could sell the produce for a profit and repay the government.

[84] Cotton and corn growers strengthened their power in Congress by forming a coalition by 1939 between South Democrats and Republicans that defeated FDR and Northern pro-labor, pro-poor interests (Finegold and Skocpol, 1995: 207).

3.7 The Ideology of the Market Machine

In the wake of the New Dealers' failed corporatism, a new political economic ideology took root in the US. Despite broad support for legislation that would create a corporatist system of governance, the NIRA and the AAA of 1933 failed to be implemented. Powerful industry interests that saw corporatist goals as unfavorable to their economic interests mounted successful legal challenges to both NIRA and AAA in the Supreme Court. In the wake of corporatism, a new ideology of the market machine took hold that drew upon Keynesian macroeconomic theories.

The ideology of the market machine proposed that the economy was no longer an extension of the natural world, with the possibility of evolving into a healthy system of competition, conflict and natural selection. Instead the economy was an inherently unstable engine. Classical economists and neoclassical economists had maintained that the economy was a self-regulating entity and the sum of its sectoral parts. As little government intervention as possible would enable unfettered sectoral markets to mature naturally, allowing the best firms to prosper, advancing society towards a "steady state" in which the supply of goods and services set optimal levels of demand. These principles provided the basis for the ideology of economic natural selection discussed above.

A new conception of the economy emerged as the Great Depression gave voice to a new generation of Keynesian economists in the US. By 1935, British Keynesian macroeconomic theories had taken hold of key advisers in the US executive branch (Barber 1996; Rosenof 1997). Keynesianism treated the economy as a mechanistic system comprised of many parts, thereby laying the basis for the field of macroeconomics. The machine metaphor suggested that the self-regulating collection of competitive firms in the US were part of a larger mechanistic system comprised not only of firms and economic sectors, but also of workers, households, governments and foreign economies. This ideology implied the presence of an engineer capable of fine-tuning the machinery of the economy, at both the macro- and micro-economic levels.

Keynesian economists attacked the core of classical economic theory. They argued that the economy was not self-regulating and needed to be controlled, thereby undermining the notion of the long run towards a steady state. Instead, Keynesians posited that the long run was really a succession of short runs, an unstable business cycle that could be understood as a "circular flow" with "leakages." As Hunt (2003, p.193) explains:

> Money flows from business to the public in the form of wages, salaries, rents, interest, and profits; this money then flows back to the businesses when the public buys goods and services from them. As long as businesses sell all they have produced and make satisfactory profits, the process continues.

This circular flow had numerous leaks. Keynes considered these leakages to be inevitable. He saw that capitalists do not re-invest all of what they accumulate back into the market, and neither do households spend all of their income to purchase goods and services owned by capitalists. Economic actors will always divert some capital outside of the circular flow to savings, to purchase imports and to pay taxes. Given these leakages, the economy was inherently unstable, and would require constant mechanical adjustments to mitigate the leakages of the circular flow. While there was no way to plug the leaks, the leaks could be compensated

for by injecting various forms of capital back into the circular flow at key points: (i) offsetting imports with exports, (ii) using taxes to finance government spending programs, (iii) financing private investment in capital goods using capitalists' accumulated wealth (Hunt, 2003, p. 194-196). It was this second lever that spoke most to state actors in the 1930s; governments could spend as a way to manage aggregate demand and keep the economy as fully employed as possible, with little need to engage in the microeconomic managing of specific sectors (Barber, 1996; Rosenhof, 1997).

Like Marx, Keynes viewed periodic depressions as the result of the accumulation of capital and observed the propensity of capitalists to save most of their income rather than reinvest in the economy, thereby disrupting the circular flow (Hunt, 2003: 194-196). Keynes explained the Great Depression in these terms: capitalist had pulled their resources out of the economic flow, causing massive unemployment, which reduced the economy's aggregate demand levels and created an aggregate supply glut.[85] His solution was to manage the nation's aggregate demand levels in order to keep the economy as close to "full employment" as possible. This proposal radically redefined the terms in which capital and labor confront one another by allowing the government to control the distribution of resources at a macroeconomic level (Hall, 1989).

In brief, aggregate demand management relied on the fiscal policy tools of deficit financing. During economic downturns, when the national economy fell into a slump due to low demand, Keynes proposed the government should not cut costs to balance the budget, but rather they should run a budget deficit to inject more capital into the circular flow. To run a budget deficit, governments could pursue two fiscal strategies. It could increase public spending on infrastructure, public works (e.g. construction projects to build schools, hospitals, parks), relief payments, and other public conveniences. Or, it could lower the tax rate to could encourage more household spending and spur the private sector to invest in productive activities. In theory, either approach to deficit financing (increased spending vs. decreased tax rates) would have the same effect: increase aggregate demand for labor, goods and services would decrease unemployment and stimulate the private sector's productivity. Keynes was ambivalent as to which strategy was best and maintained that the proper remedy would depend on the particular conditions of a recession (Turgeon, 1996). He believed the principal mechanism for maintaining circular flow should be through government expenditures, particularly in infrastructure and public works. On the other hand, he also believed that wealthy capitalists would always oppose policies that redistribute income away from them. So, Keynes believed it would also be important to direct government expenditures back into the hands of capital (Hunt, 2003: 195).

Keynes' General Theory revolutionized the field of economics after World War II. The war validated Keynes's theories when employment rose and effectively ended the Great Depression, providing evidence for viability of deficit spending to catalyze growth; the government borrowed to finance the military, which catalyzed economic growth.[86] Keynesians

[85] Classical theories assumed supply levels would set optimal demand. However, the Great Depression's unprecedented unemployment appeared to be the result of a supply glut. For Keynes, this glut was a problem of low aggregate demand.

[86] Throughout the late 1930s and early 1940s, it limited the planning and coordination capacities needed to facilitate Keynesian spending policies and did not pass any fiscal stimulus packages (Hall, 1989, p. 44).

voices had already been heard in the centers of economic policy before the Great Depression and WWII, but until now they had been mostly ignored.[87] Once World War II was underway, FDR became the first of many Keynesian administrations (Barber 1996; Rosenof 1997).[88] After the war, it became the dominant economic paradigm of the Western world (Hall, 1989, 53-54). But, as Hall (1989) argues, Keynesian ideas were "institutionalized" uniquely in different national settings.

In the US, the ideology of the market machine held that cyclical instability co-existed with the classical ideology of economic natural selection. Keynes had attacked the core of classical economic theory by claiming that the economy was not self-regulating and needed to be controlled by making both labor and capital more active in the economy during a slump. Even though WWII validated Keynesian strategies, neoclassical economic views remained resilient. American neoclassical economists (most notably the influential Paul K. Samuelson) accepted Keynesian economics as important to ensuring full-employment in the economy but maintained that classical principles still held true (Hunt, 2003: 198). Yet the two paradigms remained fundamentally at odds on the nature of the economy and how resources should be distributed. Neoclassical economics maintained that fair competition between firms should determine the distribution of resources in the economy, not the state as a political actor.

Even after the structural changes that capitalism underwent in the merger movement of the late 19th century, American neoclassical economists never adjusted their theories to account for concentrated economic power; they still conceived of an economy in which Adam Smith's invisible hand provided the competitive equilibrium needed for economic progress, achieved by innumerable small entrepreneurial firms competing fairly against each other and responding rationally to consumer tastes (Hunt, 2003). They accepted Keynesianism without actually developing a new, cogent theory of the economy (Colander and Landreth, 1996, p. 16-19). Keynesians, on the other hand, understood the economy to be dominated by corporate concentrations of economic power, which created cyclical instability that required a watchful macroeconomic engineer to maintain the economy's circular flow through deficit spending injections.

3.8 The Economic Engineering Tradition

The tradition of economic engineering emerged under the ideology of the market machine between the 1940s and the 1970.[89] The Great Depression, the subsequent failure of

[87] According to Turgeon (1996) and Hall (1989), Keynesian ideas first began to gain traction as an alternative to classical and neoclassical economic thinking during the Great Depression. There is little evidence that Keynes's *General Theory* influenced FDR and the New Dealers before WWII (Turgeon, 1996:3). Weir (1989) notes there were some Keynesian policy recommendations adopted by 1928, but "it was not until a quarter of a century later that Keynesian ideas, for a time, achieved recognition as the appropriate basis of national economic policy."

[88] WWII validated wartime Keynesianism in the US and elsewhere (e.g. Great Britain) as governments broke with long-standing patters of national economic policy in a rapid acceptance of Keynesian budgetary principles as a strategy for government borrowing to finance military-based economic growth. During World War II, the FDR administration (like other military Keynesians at that time Japan, Germany), neutralized monetary policy in early 1942 by freezing interest rates at 2 percent.

[89] I came across a number of other metaphors but choose "engineer" based on the discourse I observed in Keynesian economic texts discussing the economy in terms of an economic engine that would at various times overheat or overcool. Other metaphors include Abba Lerner's conception of government controlling the economic steering

NIRA as a corporatist strategy, and validation of Keynesian macroeconomics economics during WWII, inspired new state capacities focused on fixing and preventing economic downturns by ensuring adequate levels of income for both capitalists and workers. In its new role as economic engineer, the state administered periodic tune-ups to keep the economy and its constituent sectors from cooling down or overheating too fast. The general orientation of this tradition bears some similarity to corporatist strategies pursued by the FDR Administration in NIRA to manage business-labor conflicts over economic equity. But instead of forcing the private sector to devise cooperative agreements, the tradition of Economic Engineering rendered the struggle a technical problem to be solved by tweaking the nation's economy to generate more jobs and more output in an increasingly interdependent world.

Economic engineering built upon previous traditions of economic governance. It was used in conjunction with the Refereed Competition and Laissez Faire traditions. It also drew directly from the previous Progressive Era's tradition of Scientific Managerialism and incorporated some of the corporatist strategies that New Dealers' attempted in NIRA and the AAA of 1933. Importantly, it catapulted the economics profession into a position of unprecedented influence in US policymaking. Over the course of the 1940s and 1950s, economists advised policymakers on how to jumpstart the nation's economic engine when it cooled in times of low demand, or alternatively to stop it from overheating in times of high inflation. When demand was low, Keynes had advised governments to run a budget deficit to inject more capital into the circular flow, which would increase aggregate demand. Conversely, in an economic boom, when excessive demand raises the risk of inflation, the government should run a budget surplus by raising taxes or by reducing spending.

Although deficit financing served as the primary lever for tuning the economy, a variety of practices developed over three decades under the tradition of Economic Engineering, as subsequent administrations expanded the application of Keynes' theories to the US economy. Initially, US governments of both political parties practiced what Turgeon (1996) dubs "bastard Keynesiansism." A central tenet of Keynesian economics that when the government sector cuts spending in an economy during a recession, households and businesses will follow suit by acting cautiously in their spending. Productivity will stall further. In the US, however, the economic engineering tradition initially practiced Keynesian aggregate demand stimulus as a wartime measure. In peacetime, policy reverts to more orthodox fiscal practices of cutting spending to balance the budget (Turgeon, 1996). During the Great Depression, Keynes himself had urged FDR in an open letter to pursue deficit spending more broadly.[90] FDR cut spending instead. The Truman Administration (1945-1953) followed FDR's precedent and reserved Keynesian spending strategies for wartime.[91] From the point of view of Keynesians in Great Britain and

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wheel, See "The Economic Steering Wheel," (Lerner, 1983) Colander and Landreth (1996, p. 19-20) also recount how the first generation of Keynesian economists considered themselves as training to become doctors to the whole world, drawing from a mercantilist metaphor of a doctor prescribing for a patient.

[90] Keynes in 1933 wrote, "…in a slump governmental loan expenditure is the only sure means of securing quickly a rising output at rising prices. That is why a war has always caused intense industrial activity. In the past orthodox finance has regarded a war as the only legitimate excuse for creating employment by governmental expenditure. You, Mr. President, having cast off such fetters, are free to engage in the interests of peace and prosperity the technique which hitherto has only been allowed to serve the purposes of war and destruction." See Keynes (1933).

[91] The administration of President Harry S. Truman (1945–53) tripled military spending during the Korean War. Unemployment dropped to less than 3 percent, inflation stayed low due to "price controls," and consumption rose

Europe, US policy makers had only figured out how to make the strategy of government spending work insofar as it fit their World War II experience (Turgeon, 1996).

The Eisenhower Administration (1953-1961) significantly expanded the repertoire of the Economic Engineering tradition. The 1950s post-war boom indicated economic recovery, and the Eisenhower Administration responded with reduced military spending to balance the budget. Even when faced with three recessions, the government mostly refused to deficit spending to boost the economy, going against the advice of many leading US economists to stimulate aggregate demand.[92] However, as unemployment and inflation continued to rise, the Administration encouraged consumers to buy more automobiles and used non-military federal expenditures to pay for public infrastructure projects—most notably the "Eisenhower" highways. These projects were carried out in disguise under the label of national defense (Turgeon, 1996: 81). But the slackened growth of the US economy in comparison to the unprecedented growth of the USSR economy cost the party re-election (Turgeon, 1995:16). The Eisenhower Administration refused to use deficit spending, even when doing so would have supported Richard Nixon's bid for the presidency in the 1960 election. By contrast, John F. Kennedy campaigned on the promise of "New Economics" to rectify passive relationship the Truman Administration had initiated with the economy in the 1950s.

The "New Economics" of the John F. Kennedy (JFK) Administration (1961-1963) pursued the Keynesian goals of full employment, economic growth, and price stability through a strategy of aggregate demand management. To jump-start the sluggish economy, the JFK Administration followed the demand management strategy of funding public works used by FDR and Truman. The administration increased government spending on military expenditures for the Vietnam War, the space program and foreign aid (Turgeon, 1996).[93] Despite the political push back on deficit spending from conservatives, JFK argued that deficit spending was not an ideological tactic, but a technical strategy, and that government had a responsibility to maintain the nation's economic machinery as just as many European governments had done "without ideological preconception": As Kennedy (1962) explained that same year at the Yale University commencement speech:

> "What is at stake in our economic decisions today is not some grand warfare of rival ideologies which will sweep the country with passion but the practical management of a modern economy. What we need is not labels and clichés but more basic discussion of the sophisticated and technical questions involved in keeping a great economic machinery moving ahead. The national interest lies in high employment and steady expansion of output, in stable prices, and a strong dollar. The declaration of such an objective is easy; their attainment in an intricate and interdependent economy and world is a little more difficult. To attain them, we require not some automatic response but hard thought… the example of Western Europe

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steadily. These outcomes contributed to a budget surplus as employed labor and capital began to pay taxes (Turgeon, 1996: 83).

[92] Keynesians advisors recognized the need to manage the trade-offs between inflation and unemployment. In order to avoid harmful trade-offs between lowering inflation and increased unemployment, John Kenneth Galbraith, a leading US economist coming out of Berkeley, advocated for more deficit spending funded by an increase in sales tax. At the time, Galbraith believed 7% unemployment might be required to control inflation as a problem. Paul Samuelson of Harvard believed that inflation rates of as high as 5 percent per year may be required to maintain full employment (Turgeon, 1996).

[93] Foreign aid dollars were tied to a US protectionist strategy; recipients of foreign aid had to spend it is in the United States.

> shows that they are capable of solution—that governments, and many of them are conservative governments, prepared to face technical problems without ideological preconceptions, can coordinate the elements of a national economy and bring about growth and prosperity—a decade of it." (emphasis added)

The speech said little about what was "new" about JFK's New Economics program: JFK's "supply-side" stimulus strategy. JFK's planned approach initially appeared to take the advice of John Kenneth Galbraith, the leading US economist at the time. During the Eisenhower recessions, new theories about the causes of inflation and solutions were floated.[94] Galbraith asserted that inflation could be controlled with slightly higher unemployment (around 7 percent) (Galbraith, 1957). In order to avoid a trade-off between inflation and unemployment, Galbraith advocated more deficit spending supported by an increase in sales tax. The JFK Administration the strategy of aggregate demand management via deficit spending, but did not increase sales tax. Instead of raising the sales tax to collect revenue for public programs as Galbraith proposed, the administration piloted a sector specific supply-side strategy designed to maintain income levels through tax cuts. JKF asked Congress to cut income taxes by $10 billion despite the budget deficit. Reducing the marginal tax rate (the tax on additions to income) would increase the supply of private investment in the economy. In addition JFK's economic advisers proposed cutting business taxes in the form of an investment tax credit supplemented by the institutionalization of rapid depreciation write-offs (Turgeon, 1996; Hall, 1989). In theory, supply-side measures would pump private money into the economy (Turgeon, 1996). Kennedy explained the rationale behind his fiscal approach to a Wall Street crowd in 1962:

> To increase demand and lift the economy, the Federal Government's most useful role is not to rush into a program of excessive increases in public expenditures, but to expand the incentives and opportunities for private expenditures.

JFK's "New Economics" added an alternative tool to the nation's political economic toolbox of Economic Engineering. The basic logic underlying this supply-side stimulus strategy was that freeing up capital would enable capital to invest in greater productivity. Greater private investment in the building blocks of productivity (e.g. industrial infrastructure upgrades, worker training, and technological innovation) would increase national economic output. This assumed that increased economic output would also bring the economy to full employment. While the Keynesian objective of full employment is the same for both supply-side tax cuts and demand-side deficit spending, these tactics differ in their implications for which groups steer the national economy. In demand-side deficit spending, the government makes strategic investments, while supply-side tax cuts assume that lower tax rates will encourage private actors to invest and revive the economy.

The Lyndon Baines Johnson (LBK) (1963-1969) Administration pushed JFK's tax cutting proposals through Congress. The Revenue Act of 1964 also included a wage-price guidepost (an income policy that kept wage increases in line with productivity as an additional

[94] Towards the end of the Eisenhower administration, both unemployment and inflation continued to rise. Leading economists interpreted this as natural down cycle resulting from some new combination of factors causing inflation, including economic output outpacing consumer demand, government decreasing its spending, and government raising interest rates in order to dampen inflation and protect profit (Turgeon, 1996:15). This means that there were now two kinds of inflation to worry about: Demand-pull inflation (when the economy over-heats and too many dollars chasing too few goods) as well as a potentially new supply-push inflation (or a wage-push inflation, when the economy is cooling and too few dollars chase too many goods).

measure to manage inflation) and liberalized depreciation rules. By the end of 1965, employment, consumption, and investment all grew, and the economy appeared to be reaching "full employment" (unemployment rate at 4 percent) (Turgeon, 1996). LBJ continued JFK's repertoire of deficit spending on both military and non-military programs, including the Vietnam War, Johnson's War on Poverty, and various public works projects. He also directed public investments into health care, education, mass transit, energy and infrastructure. Tax revenue increased and the federal deficit began to melt. The president's annual economic report declared the nation had advanced towards its economic goals of full employment, rapid growth, and price stability, with the budget nearly balanced (Council of Economic Advisors, 1964). Johnson's domestic spending programs for the War on Poverty and the Vietnam War kept the economy operating at full capacity. Yet by the end of 1968 the surplus budget was draining fast from the Vietnam War.

With Kennedy's strategy of supply-side stimulus added to the repertoire of Economic Engineering, Keynesianism strategies finally achieved recognition as the appropriate basis of national economic policy after almost two decades (Turgeon, 1996; Hall, 1989). Kennedy's use of supply side stimuli initially upset traditional Keynesians in the Democratic Party as well as Republican Party conservatives who worried that cutting taxes while spending would be fiscally ruinous. However, the overall approach of reduced income and investment taxes was soon accepted in both parties. Although the term "supply-side" economics did not become commonplace until the late 1970s, mainstream economics considered intervention in the supply-side of the economy to be an effective tool when a stable level of aggregate demand did not appear to be enough to stimulate investment and growth. Variation in the tax rates — not spending — became the preferred way to stimulate the economy, inspiring Milton Friedman in the late 1960s to claim "we are all Keynesians now."

3.9 Conclusion

US political culture continues to evolve in ways that draw upon the various traditions of economic governance discussed in this chapter. In the next chapter, I explore how these traditions have continued to shape the evolution of the US political culture of economic governance in ways that impact ethanol policy making. Chapter Four also aims to explain how ethanol policymaking has provided a site for negotiating US political culture of economic governance.

Since the 1970s, almost all administrations have coupled deficit spending strategies with supply-side stimuli strategies, but overall the Keynesian tactic of pursing full employment using aggregate demand management has fallen out of favor in Congress. The Reagan Administration's full-scale attack on Keynesianism has had a lasting impact on US political economic culture. Reagan, who inherited a large increase in military spending planned by Carter, carried out his campaign promises with three successive cuts in income tax. For subsequent administrations, the emphasis on balancing the budget has restrained Keynesian practices, even as non-military public spending in health care, education, mass transit, energy, and infrastructure has enjoyed a record of improving employment rates. Keynesian demand-side strategies are considered politically risky to date.

The Economic Engineering strategy of aggregate demand management continued as the main feature of US economic policy up until the 1970s, at which point supply-side tax reductions became the more prominent approach. Both Republicans and Democrats have increasingly turned to supply side strategies. Even President Clinton, who claimed to have replaced Republican supply-side economic policies with "invest and grow economics" (Clinton 1997), pursued an economic governance strategy that fit the larger mold of supply-side strategies that emphasize investment in the building blocks of economic output, namely by incentivizing public-private partnerships in education and science and technology. To some degree the first Bush Administration pursued this approach as well.

However, the key difference between parties has been their willingness to design supply side stimuli that use public as opposed to private capital. Publicly funded supply-side stimuli is similar to demand-side Keynesian policies in its overall willingness to use public funds. However, the two approaches remain distinct in that aggregate demand management aims explicitly to achieve full employment, whereas supply-side approaches assume indirect positive employment impacts. The overall goal of full employment as a way to heat up the country's economic engine remains desirable to many in the US Democratic Party, but using demand management as a means to that end has lost the legitimacy it once had in the 1960s.

As described in the next chapter, the Carter Administration piloted this general approach to using public funds for supply-side stimuli. The Administration inherited a struggling economy faced of stagflation and the OPEC crisis (the other big economic event of the 1970s) at a time when state actors believed the repertoire of existing remedies no longer worked. The OPEC crisis resulted in huge increases in oil prices, worldwide inflation, and an international financial crisis. Moreover, US administrations in the 1970s struggled to find a solution to the US balance of trade, especially the problem related to rising imports from Japan. From the 1940, 1950s and 1960s, the US economy had been untested by international competition. Even the U.S.S.R. did not present an external economic challenge. In 1964, the word "trade" had not yet appeared in the president's annual economic report. Since rebounding from the Great Depression, the American economy had been responsible for 60 percent of manufactured goods globally.

Aggregate demand management did not appear to be working to solve these problems, and President Carter's economic advisors were divided over how to interpret the underlying cause of stagflation. Traditional economic theory's framework left them with worsening trade-offs between inflation and unemployment. The Carter Administration experimented with a combination of strategies culled from old traditions of economic governance. For instance, even as Keynesian logic appeared to be coming unglued, Carter raised the budget deficit to $74 billion a year and proposed a large increase in military spending.

But he also experimented with new strategies, some of which innovated on the supply-side stimulus tactics of his predecessors. Carter's particular approach to combining supply-side stimulus and aggregate demand management flew in the face of the advice of a new class of classical economists began to assert the superiority of supply side theories to Keynesian demand management. They agreed that Keynesian proposals to increase tax rates to fund deficit spending only impacted aggregate demand without doing anything to improve productivity. Rather than focus on manipulating aggregate demand, this new epistemic community of supply-sider

economics advocated a focus on manipulating aggregate supply, namely changing marginal tax rates to impact the amount of goods and services available on the market. But the Carter Administration took a different approach to supply-side stimuli in the face the OPEC crisis.

Chapter 4 From battlefield to bio-economy: Ethanol imaginaries and policymaking in the US

Contemporary US ethanol policymaking has its roots in the oil price hike of the 1970s, which provided the first major policy window for the industry. Unlike its Brazilian counterpart, the US ethanol industry struggled for decades to grow its market share in the country's domestic transportation fuel market. Despite its slow start over the 1980s and 1990s, the US ethanol industry entered a growth period in the early 2000s. American producers surpassed their Brazilian counterparts in ethanol production in 2007. Today the US is the world's leading supplier (IEA, 2011).[95]

Yet ethanol remains one of many alternative energy options for consumers, and gasoline continues to fuel the vast majority of US automobiles (US EIA, 2017). Even as ethanol consumption increases globally and new marketing opportunities emerge, US ethanol producers express frustration at their inability to capture more market share, pointing to unnecessary saturation in the domestic market due to the ethanol "blend wall": the cap set by the US Environmental Protection Agency (EPA) on how much ethanol can be mixed with gasoline at retail pumping stations.[96] Despite the strength of the corn ethanol lobby and its influential ties in both the Republican and Democratic parties, industrial policies for ethanol have failed to break through the blend wall; the amount of ethanol in the average American gas tank still lags behind those of Brazilian cars and trucks. Some relate the ethanol industry's struggles to the US government's lack of a comprehensive energy strategy and support for a range of alternative transportation fuels (Davis 1993). Certainly, the oil industry has played a role in what can be read as a tug of war over American gas tanks, with the agricultural and oil lobbies on opposing sides. But these interest group politics have been a constant feature of US ethanol policymaking, and do little to explain the forces shaping the US trajectory of ethanol development. It is also difficult to link the industry's success to any single policy program (Solomon et al., 2007). Nor can the most recent set of US ethanol policies of the 2000s be explained purely in terms of policy responses to the problems of oil price hikes, energy insecurity, or climate change.

In this chapter, I argue that in order to understand the trajectory of ethanol development in the US, it is necessary to examine the history of ethanol policymaking against the backdrop of the US's evolving political culture of economic governance (see the previous Chapter 3). As discussed in Chapter 2, I use the concept of sociotechnical imaginaries to explore how political

[95] As 2010 corn harvests increased in the US, 2010 sugarcane harvests decreased in Brazil, which led to significant reductions in Brazilian ethanol output. Higher U.S. volumes of ethanol began entering Brazil to meet domestic demand, creating a reversal in traditional ethanol trade patterns. See EIA (2014).

[96] Ethanol producers have long argued that the EPA's blend wall unnecessarily keeps more ethanol out of gasoline. The "blend wall" refers to the 10 percent blending mandate issued by EPA for the nation's gasoline supply. Small engine manufacturers and oil industry interests maintain that a higher blending ratio will cause corrosion leading to damage in for lawn mowers, snow blowers, boats and even cars. Ethanol supporters have long sparred with the oil industry in advocating that the EPA raise its ethanol blending mandate. The EPA's Office of Air and Radiation has pledged to expand the use of E15 and E85 blends, and although the EPA began allowing up to a 15 percent blend in 2011, it still has not changed its mandate beyond 10 percent as of 2016.

culture shapes ethanol policymaking, as well as how ethanol policymaking helps constitute the US's political culture of economic governance. The first ethanol imaginary emerged not only in the midst of an energy crisis, but also amid an existential crisis of the state, in which government leaders struggled to solve a number of economic policy problems. The Carter Administration was divided internally over how to fix stagflation, provide consumers with affordable energy, and increase national productivity. The administration's ethanol policies attempted to solve a piece of these problems by mandating an increasing volume of ethanol consumption in the nation's transportation system over time.

The Carter Administration's approach not only proposed to supplant gasoline, but also to launch a new strategy of supply-side stimulus under the tradition of "Economic Engineering" discussed in the previous chapter. Carter's ethanol mandate would have significantly broadened the authority of the state in sector-specific growth. However, this strategy ultimately undermined the ethanol imaginary it proposed to achieve. The Republican Reagan Administration, first elected in 1980, subsequently cut implementation of Carter's mandate and defunded key ethanol support programs. Yet, as the case below details, the components of Carter's ethanol imaginary would reappear in the imaginaries of subsequent administrations. Both the administrations of George H.W. Bush and George W. Bush attempted to revive the Carter Administration's supply-side strategy of mandating ethanol consumption, albeit cloaked in the EPA's statutory authority under the Clean Air Act. This strategy finally saw success under President George W. Bush. In contrast, although the Clinton Administration did not pursue an ethanol mandate, it reimagined ethanol as a technological silver bullet for climate change and a platform for launching the future bio-based economy of fuels, chemicals, and plastics made from cellulosic feedstocks. The Obama Administration continued to implement this imaginary with its "Bioeconomy Blueprint" plan.

However, struggles remain over what role ethanol should play in the country's future, given new imaginaries for solar-energy powered transport and agricultural development. Although the sociotechnical imaginary of ethanol as a building block for US-based agricultural and biotechnology firms has helped expand the global bioeconomy, ethanol's future continues to be hindered by tensions in the US political culture of economic governance, as well as by concerns about its impacts on climate change, agroecological landscapes and livelihoods.

In the sub-sections that follow, I provide a short history of ethanol in the US and then turn to an analysis of three successive sociotechnical imaginaries for ethanol. For each imaginary I highlight the ways in which state actors determine the role that ethanol will play in the nation's future, and the role of the state in achieving this future. Together, the three imaginaries constitute a genealogical analysis of ethanol statecraft. As a case study of green industrial policymaking, the US trajectory of ethanol development reveals how ethanol statecraft is shaped by internal tensions within the state about how it should best participate in economic life. Further, the study of ethanol imaginaries suggests that state actors use imaginaries to renegotiate contemporary roles for the state in US economic life amidst the path dependent forces of national political cultures of economic governance.

4.1 A short history of ethanol as a sociotechnical system in the United States

The history of ethanol, or "ethyl alcohol," in the United States can be traced back to the mid-nineteenth century. Alcohol made from farm commodities was used as a popular lighting fuel until the Revenue Act of 1862, which taxed all alcohols—both industrial alcohols and drinkable denatured alcohol—to help pay for the Civil War (Carolan, 2009). At the same time, the US oil industry was taking root in Pennsylvania (Black, 2000). However, it would be over another fifty years until automobile manufacturing stabilized around gasoline engines. Although ethanol was celebrated throughout Europe as the preferred fuel for automobiles, stoves, lamps, and farm machinery in the early 1900s,[97] its popularity in the US continued to be undermined by policies that failed to distinguish ethanol fuel as an industrial product from ethanol as an alcoholic beverage. For example, even after the repeal of the tax on ethanol, ethanol remained more expensive than gasoline because of the denaturing requirement—a process used to make ethanol drinkable.

Eventually, interest in ethanol dwindled as a powerful, entrenched sociotechnical system took shape around gasoline (Carolan, 2009).[98] That gasoline came to be the preferred choice of automotive fuel in the US is a testament to the oil industry's successful push for automotive engineering designs that would ensure a market for gasoline (Black, 2000). Given its status as a farm product, ethanol at one point enjoyed a competitive edge over gasoline as a fuel for agricultural machinery. In 1917, Henry Ford advertised his Fordson Tractor as a flex-fuel vehicle that could run on either ethanol or gasoline (Carolan, 2009). Furthermore, by many accounts, gasoline was the poorer quality fuel, requiring innovations to make lower compression engines. The first internal combustion engines could run on either hydrous ethanol or gasoline. As sociologist Michael Carolan (2009: 427) writes:

> I can find no clear indication as to which was considered the clearly superior fuel: gasoline, alcohol, or a blend of both. If anything, the bulk of evidence points to alcohol as having greatest support among scientists and automobile engineers. Other than being cheaper than alcohol at the pump – although hidden costs (like increased insurance premiums) make the issue of 'price' more complex – gasoline did not appear the obvious victor.

Ethanol's re-emergence as an alternative to gasoline during the 1970s OPEC oil embargo would not have been possible without the rise of another of the US's major sociotechnical system: the corn wet mill. In the US, ethanol has traditionally been made from what is commonly known as "yellow corn" grown by farmers predominantly in the upper Mississippi and Ohio River Valley, as opposed to the corn that dairy and livestock producers grow in smaller amounts for animal feed. Although ethanol can be produced from a wide range of feedstocks, most US ethanol plants continue to use corn (Casey, 1977).

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[97] Carolan (2009) lists a number of indicators of the real and potential interest in ethanol as a transportation fuel in French, Germany, and most notably Greece, where the government was forced to impose an alcohol fuel tax to compensate for the loss of revenues from petroleum taxes.

[98] Bijker (1995) uses the term "sociotechnical" to argue that technological change and social change are inherently intertwined and must be examined together to understand where technologies come from and how societies deal with them. For similar arguments from other scholars of the social construction of technology (SCOT), see Pinch and Bijker, 1989.

Corn can be transformed into ethanol through two production models: wet-mill production and dry-mill production. Although the final product of both milling models is anhydrous ethanol, the two production systems differ importantly. Dry milling model features ethanol as its main product. By contrast, the wet-mill model produces ethanol as a by-product. In a wet-mill, corn is washed, crushed, and milled into a cornstarch slurry. This slurry is the feedstock for multiple end products for the livestock industry (animal feed) and the food processing industry (cornstarch, corn oil, germ) (Keeney 2009; Porter and Spence, 1982). Ethanol is made from the residual cornstarch stream that remains after other products are extracted and processed from the slurry. Of the two models, wet-mills have dominated corn ethanol production due to their economies of scale.[99] These plants are predominantly owned by large multinational commodity processing and trading firms like Cargill and Archer-Daniels-Midland. Due to the wet-millers' economies of scale and diverse product range, the industry has functioned as an oligopoly; there are few opportunities for smaller firms to compete with handful large processors (Thompson, et al. 1996).

Starting in the 1970s, the corn wet-milling industry pushed to market ethanol as a transportation fuel in parallel with its efforts to produce high fructose corn syrup (HFCS), a liquid sweetener alternative to sucrose (common table sugar). Wet-mills developed ethanol as a co-product to HFCS amid surging sugar prices. The two products are made from the same cornstarch slurry stream in the wet-mill that produces sugar molecules from corn syrup that can be broken down in varying degrees. Ethanol requires the extra steps of fermentation and distillation.

Surges in global sugar prices provided a window of opportunity for the corn wet-milling industry to market cornstarch in the 1970s. Domestic and world sugar prices after World War II fluctuated due to production shortfalls, and began to rise significantly in 1964 because of low global production. Amid the energy crises, high inflation, and global commodity shortages, sugar prices surged even higher between 1970 and 1975, but then crashed in 1975 (Lewis, 2012). The US responded with a number of sugar policy programs to support sugar processors.[100] However, these programs had the effect of increasing domestic sugar prices, and downstream industries responded by looking for alternatives (Casey, 1977). The corn wet milling industry's existing products of corn syrups and dextrose lacked the sweetness required to compete directly with sugar made from sugarcane and beets (White, 2008). Corn processors invested in R&D to find a sugar replacement. A series of innovations in the late 1960s created HFCS as a sugar alternative that could be produced at lower production costs than other sugar processors (Casey 1977). Due to its high fructose content and substitutability as a liquid sweetener, the wet-milling industry

[99] However, the large majority of ethanol plants built during the expansion-phase of the U.S. grain/starch ethanol industry leading up to the 2008-2009 period made use of corn dry-milling processes.

[100] Previous domestic sugar policy programs ended when domestic prices and world prices evened out, eliminating import restrictions and producer payments. But when sugar prices crashed in 1975, the United States Department of Agriculture responded with a sugar price support program for sugar processors and producers. In return for a subsidy set at 13.5 cents per pound, processors had to pay beet and cane producers a predetermined price. The 1977 US Farm Bill gave processors even better terms. The 1977 Farm bill granted the Secretary of Agriculture the authority to set domestic sugar prices at a minium market price established according to the duties applied to imported sugar and to reduce the risk faced by processors by allowing processors to use sugar as collateral for loans under a non-recourse loan program. The government also institute a tariff rate quota. For more information, see Lewis (2012).

was able to compete in the soft drink industry as a replacement for sugar (Thompson, et al. 1996).[101]

As a by-product of HFCS, the fate of corn ethanol in the US has long been inextricably tied to the fate of corn wet-millers' value chain for beverage sweeteners. HFCS has remained immune from the volatile swings in price and availability of sucrose throughout the 1980s and 1990s, in large part due to a series of policies that have sheltered HFCS prices from lower world sugar prices. HFCS and government support policies enabled large profits and increased investments in the wet milling industry during periods of high competition in from other sweeteners (Thompson, et al. 1996). The success of HFCS has been benefitted ethanol, arguably allowing it to stay on the market despite its difficulty in gaining market share in value chains dominated by the petroleum industry, such as the fuel additive market and the transportation fuel market.

Ethanol's fate began to decouple from corn wet-milling as it gained status as a biofuel in the 2000s. As detailed in the sub-sections below, federal biofuel production mandates incentivized greater ethanol production under the US Renewable Fuel Standard, which was established in the 2005 Energy Policy Act and the 2007 Energy Independence and Security Act. Between 2000 and 2009, the number of US biofuel refineries grew from 54 to 193, and biofuel production grew from 1.6 billion gallons per year (BGY) to 12.4 BGY (Gillon, 2010). Within this growth trend, the US Renewable Fuel Standard spurred the construction of new dry-mill ethanol plants that produced the animal feed produced "dried distillers' grains and solubles" as a by-product of ethanol.

4.2 Ethanol as Arsenal in the Energy War

The first ethanol imaginary produced by the US state emerged during the Carter Administration (1977-1981) amidst the second OPEC energy crisis. Carter declared the energy crisis to be the "moral equivalent of war," invoking a strong wartime state called into action for national security (Carter, 1977). His predecessor, President Nixon, had also employed a national security frame in his attempt to address the first OPEC oil embargo with his "Project Independence" proposal—a long-term planning initiative to increase the country's existing domestic fossil fuel supplies. Nixon (1973) had invoked "the spirit of Apollo" and "the determination of the Manhattan Project" for the energy crisis, presenting Americans with a familiar Cold War dictum in which the state is the only entity equipped to harness America's exceptional science and technology in the face of a foreign threat.

The Carter Administration took a different approach, focusing on strategies to commercialize existing solar technologies, to develop new synthetic fuel innovations, and to increase energy conservation in the transportation sector. As President Carter championed alternative energy initiatives as the route to energy independence, the corn wet-milling industry led by Archer Daniels Midland (ADM) lobbied for a subsidy program to use corn-based ethanol as a readily available supplement for gasoline supplies (Gardner, 2007). Subsidized ethanol production would add value to the corn processors' production of high-fructose corn syrup

[101] As a liquid sweetener, HFCS can be pumped from delivery vehicles to storage and mixing tanks with little dilution before used as an ingredient in beverage product formulation.

(HFCS) and increase market prices paid to corn farmers. The corn industry argued that state subsidies for ethanol would be politically justified as a mechanism to reduce government payments to farmers, as well as supplement gasoline supplies (Gardner, 2007).

Congress passed the Energy Tax Act of 1978, the first of many sector-specific supply-side policies designed to increase the ethanol production output for the corn wet-milling industry. The law's central feature was what came to be known as the "Blender's credit." This tax credit for gasoline blended with at least 10 percent ethanol, then known as "gasohol," exempted oil companies and fuel blenders from the 4-cent federal excise tax on gasoline until 1984, when it would be up for renewal. The law also provided loan guarantees for new ethanol plant constructions, investment tax credits for ethanol production, import tariffs on Brazilian ethanol, and general R&D funding for alternative fuels including biomass-based fuels like ethanol (Libecap, 2003). Justification for the Blender's Credit rested on the indefinite claims that ethanol subsidies would create net savings for the government: by incentivizing ethanol consumption, corn prices would rise, which in turn would reduce the need for subsidy payments to corn farmers (Gardner, 2007). This justification shifted as President Carter articulated a more ambitious future for ethanol.

The following year, the Carter Administration made ethanol a major cornerstone of a comprehensive energy plan. This move came at a time when the US government was saddled with a "crisis of confidence," not only among the general public but also within the state.[102] A dizzying array of national problems included heightened public distrust of the executive office after the Watergate scandal, inflation, high unemployment, a farming crisis, low output by domestic industries, a rising tide of imports from Japan, and the OPEC energy crisis—the big economic event of the 1970s that had set off huge increases in oil prices, worldwide inflation, and an international financial crisis.

Amidst these myriad crises, the US approach to economic governance underwent an existential crisis. Throughout the 1970s, presidential economic advisors were preoccupied with the question of how to interpret the underlying causes, and with developing appropriate solutions to the worsening trade-offs between inflation and unemployment. In the Carter Administration, economic advisors were divided sharply about what the approach should be. To address the oil crisis, Keynesians had proposed a price-fixing solution, but this had failed. To address the problem of US industries losing market share to the rising tide of imports, protectionist trade policies proved insufficient and prompted a backlash from the international community (Graham, 1992, p. 30-2). The strategy of aggregate demand management had fallen out of favor in Congress creating malaise over how to solve unemployment. In short, many of the reliable tools from the US traditions of Economic Engineering and Scientific Managerialism (See Chapter 3) appeared to no longer work, leaving policymakers confused about which policy tools to apply to which problems.

The US political culture of economic governance appeared to be shifting as the Carter Administration experimented with new approaches to solving stagflation and the doubling of gas prices. Drawing from the toolbox of Economic Engineering, Carter appointed monetary technician Paul Volcker to the head of the Federal Reserve, who succeeded in slowing inflation

[102] Carter (1979) used this term in his famous "Crisis of Confidence" speech.

at the cost of increasing unemployment. The administration's counter inflationary measures included fiscal austerity, deregulation of the energy and transportation sectors, tax breaks for industry, a freeze on federal hiring, and a pledge to cut the federal deficit in half, as directed by the Full Employment Bill of 1945. The gasoline problem proved to be more politically complex than appointing an expert to fine-tune the country's economic machinery.

Carter's 1979 solution was for the state to lead the charge to "win the energy war" by developing an arsenal of alternative technologies to deploy on the "Battlefield of Energy." In his 1979 "Crisis of Confidence" speech, Carter rallied the nation to end America's dependence on oil by developing a new arsenal of fuels, sidestepping the question of how the administration would address stagflation to address other pressing problems. By mobilizing the nation's technological prowess in the energy sector, Americans could regain their faith in government's ability to "take control of its common destiny" by developing wind, synthetic fuel and ethanol energy systems (Carter, 1979). Drawing on the logic of the wartime state, Carter (1979) proposed:

> …the creation of an energy security corporation to lead this effort to replace 2y/2 million barrels of imported oil per day by 1990. The corporation will issue up to $5 billion in energy bonds, and I especially want them to be in small denominations so that average Americans can invest directly in America's energy security. Just as a similar synthetic rubber corporation helped us win World War II, so will we mobilize American determination and ability to win the energy war. Moreover, I will soon submit legislation to Congress calling for the creation of this Nation's first solar bank, which will help us achieve the crucial goal of 20 percent of our energy coming from solar power by the year 2000. These efforts will cost money, a lot of money, and that is why Congress must enact the windfall profits tax without delay. It will be money well spent. Unlike the billions of dollars that we ship to foreign countries to pay for foreign oil, these funds will be paid by Americans to Americans.

The imaginary of ethanol as technological arsenal entailed a more prominent position for ethanol producers in the country's future transportation fuel system than previously implied by the Blender's Credit. The Carter Administration's ethanol imaginary required diversifying production to include new classes of ethanol producers with smaller, dedicated ethanol plants; no longer would the corn wet-mill industry dominate ethanol production. Moreover, these ethanol producers were envisioned to be the primary beneficiaries of new cellulosic conversion technologies developed under a government R&D program. Once commercial scale cellulosic conversion technologies were ready to deploy, producers would be able to convert grasses and agricultural wastes into ethanol—two feedstocks that would not be easily incorporated into a wet-mill system but would be used by dedicated ethanol plants. This more diverse set of producers and feedstocks would help make ethanol 'naturally' price-competitive with gasoline (Feldman et al., 1982). The state envisioned a new ethanol industrial landscape, populated with a combination of large wet corn mills, smaller, dedicated ethanol plants, and a diversity of bio-based feedstocks

To achieve this imaginary, Carter pursued an unorthodox supply-side stimulus strategy, which Congress passed into law in 1980. The Energy Security Act, Omnibus Reconciliation Tax Act, and Gasohol Competition Act. These laws aimed to harness the nation's technological prowess to protect US consumers against the upheavals of international oil prices. They included cutting taxes, deregulation of energy and transportation sectors, and government spending to stockpile fossil fuel alternatives, including wind, synthetic fuel and ethanol.

These policies positioned ethanol more prominently as a long-term solution to gasoline consumption as well as a device to reinforce the state's governing capacities. The Biomass Energy and Alcohol Fuels Act under the Energy Security Act of 1980 established a loan guarantee program for new ethanol producers, a tariff on Brazilian ethanol, and additional tax provisions for ethanol producers and blenders. The centerpiece of the act included $1.2 billion for loans and loan guarantees to finance the construction of ethanol plants. It also established the Office of Alcohol Fuels (OAF) at the Department of Energy (DOE) to oversee long-term ethanol planning in order to ensure ethanol constituted ten percent of domestic gasoline consumption by 1990. The OAF was given the authority to set ethanol consumption that exceeded the 1990 ethanol target. The OAF would also administer financial assistance to help smaller ethanol producers reach commercial scale production. The law also established the Federal Gasohol Plan, a joint effort between the DOE and the USDA to meet the OAF's ethanol consumption goals. In addition, the controversial Crude Oil Windfall Profit Tax, enacted that year, extended the federal excise tax exemption for gasohol from 1984 to 1992. It also established an additional incentive, 10 percent Energy Investment Tax Credit, for plants and refineries that used fuel sources other than petroleum to make biofuels. Finally, increased R&D funding targeted cellulosic conversion technologies to one day broaden the raw material base of the ethanol industry.

These strategies drew upon the US traditions of Scientific Managerialism and Economic Engineering but with a micro-economic approach. The Carter Administration repurposed the supply-side stimulus strategy from the US tradition of Economic engineering to achieve technology-specific goals in the energy sector. Rather than pursue broad tax cuts and investment credits that encouraged private capital to invest in greater productivity as it saw fit, these policies applied these tools more narrowly to specific groups of producers and technologies. At the same time, the creation of the OAF, the Federal Gasohol Plan, and new government-funded R&D initiatives expanded the authority of the state. Specifically, the creation of a new cadre of ethanol experts to steer ethanol development with carrots and sticks in the form of subsidies and a mandated ethanol market, alongside major investments in technological research, reinforced a version of economic governance in which the state provides sector specific expertise, not simply to help corporate capital, as a way to fine tune the nation's larger economic machinery into running more smoothly.

The Carter Administration's ambitious vision for ethanol dissolved before it could materialize. Carter lost the 1980 election to Ronald Reagan, largely due to an early recession. When the Reagan Administration (1981-89) arrived a year later, government programs to stockpile energy alternatives like ethanol all but died. Reagan reframed Carter's energy war as a no-growth strategy forcing Americans to "share scarcity" (Bureau of National Affairs, 1981: 1115). For the Reagan Administration, America's energy crisis would be solved by the Laissez Faire tradition of economic governance. Restoring the free market would unleash the creative energies of the private sector. Abundant domestic energy sources were readily available, once state permits provided private developers access to federal lands (Reagan, 1981). Reagan cut funding through a series of executive orders and appropriations legislation that effectively starved the OAF's ethanol program and almost erased ethanol from the definition of "renewable energy," which was re-defined as wood, water, solar and "other." Ethanol tariff and tax

provisions remained namely the Blender's Credit due to pressure from a strengthening corn ethanol lobby and their representatives in the Senate (Lazzari, 2007).

The two parties divided more bitterly during this time, as Reagan's approach to economic governance diverged more sharply from the Democrats' preferred Keynesian framework of Economic Engineering. Reagan deepened tax cuts and increased deficit spending, much of which was justified in war terms. Both parties had criticized Carter's peacetime approach as the imprudent use of public resources on "reindustrialization" and "industrial policy." Republicans attacked the administration for activist "winner-picking" and "loser-fixing," and Democrats rebuked Carter's break with the party's traditional Keynesian approach to making macroeconomic adjustments (Morgan, 2004, p. 1023-61; Brinkley, 1998). However, as the US trade deficit and unemployment continued to worsen under the Reagan Administration, Democrats and Republicans differed strongly on how to address the improvement of American productivity. Japan threatened US leadership in technology, and old-line manufacturing firms appeared unable to upgrade to the new competitive environment. Democrats argued for careful, long-term coordination of industrial activity, and Republicans proclaimed coordination at the sectoral level using public resources amounted to 'picking political winners and losers'—a practice they believed would prove ruinous to both the state and industry (Hughes 2001).

The Reagan Administration developed a new approach to agricultural policy. Congressional farm advocates introduced legislation to continue funding of rural development efforts; most of these efforts failed in the mid-1980s. For example, a bill introduced in 1984 proposed to create a Rural Development Administration that would manage rural development programs separate from USDA farm services. This bill's emphasis of direct provision of housing for the rural poor contrasted with the Reagan USDA's farm programs and broader efforts to create "rural enterprise zones." The latter strategy, introduced in a 1987 bill, sought to adapt a state-level approach to redeveloping distressed urban areas by granting significant tax relief to businesses willing to invest in designated urban enterprise zones.

However, some common ground formed around the practice of government spending to achieve new innovation-oriented programs housed in federal agencies (Block and Keller, 2011; Schrank and Whitford, 2009). By channeling public resources toward R&D projects, the state would help improve domestic firms' position in global markets and create high-technology employment at home. Such programs built upon the post-war model of government support for basic science in medical and defense (Kleinman, 1995), but did so in a way that posited better S&T as an important public subsidy needed to get American industries back on track. Reagan supplanted Carter's energy war with a space-based Strategic Defense Initiative to upgrade the nation's military in the face of Soviet threats. Reagan's "Star Wars" program can be seen as laying the groundwork for the future re-militarization of American power. The Reagan Administration also instituted the Advanced Research Projects Agency (ARPA) (renamed DARPA for "Defense") to support information technology and semiconductor firms. DARPA also launched the Human Genome Project to support biotechnology firms. Such programs lay "below the ideological surface," operating through less centralized avenues where they were neither highly visible nor actively concealed from public debate (Etzkowitz et al., 2008, p. 685). This is what Block (2008, p. 182-3) calls the "US hidden developmental state."

4.3 Ethanol as Clean Air Technology verses a Renewable Fuel

A new vision for ethanol emerged in the late 1980s as a clean air technology. In this imaginary, ethanol functioned as an additive that could be blended with gasoline to increase the amount of oxygen as a strategy for lowering carbon monoxide emissions from automobile tailpipes in areas that struggled to meet National Ambient Air Quality Standards set by the EPA. By reimagining ethanol as a technological solution to air pollution, the Bush Administration sought to incorporate ethanol into its 1990 Clean Air Act Amendments. Doing so promised to create a new marketing opportunity for ethanol producers, who had struggled to grow under the previous Reagan Administration. This approach was basically an attempt to cloak an ethanol consumption mandate in air pollution control regulations and reflected the logic of the hidden developmental state. However, this approach was compromised by the very vehicle that promised to usher ethanol into new markets: The Clean Air Act's mandate to regulate harmful air pollution put a spotlight on some of ethanol's less desirable chemical properties.

The Clinton Administration attempted to rescue the strategy of using the Clean Air Act to market more ethanol by proposing a second imaginary: ethanol as a renewable fuel. In this imaginary, ethanol was defined as a renewable oxygenate—valuable not for its air quality benefits but for its status as a product made from domestically grown agricultural feedstocks. This imaginary also encountered problems under the Clean Air Act, albeit in a different form. In a lawsuit filed by the petroleum industry against the EPA, the courts struck down the EPA's "renewable requirement." The decision hinged on the EPA's lack of authority in dictating blending requirements that were not explicitly written into the Clean Air Act. Thus, ethanol's dubious air quality benefits as a gasoline additive, and the state's limited economic governance authority within its environmental policy capacities, undermined two ethanol imaginaries over the course of the late 1980s and early 1990s.

Despite the setbacks of the Reagan years, the ethanol industry continued to pressure lawmakers to re-establish a national ethanol consumption mandate and maintain the Blender's Credit. Absent subsidies to support growth, ethanol output increased very modestly throughout the 1980s and 1990s. Production became even more concentrated when smaller producers could not weather a drop in gasoline prices (Solomon et al. 2007). The corn wet-milling industry endured accusations of corporate welfare in their attempts to renew the Blender's Credit (Reitze, 2001). Congress proposed the Ethanol Motor Fuels Act of 1987 to establish a national consumption goal of five billion gallons of ethanol per year. However, the bill crumbled under accusations of corporate welfare failed in the House (Libecap, 2003). The next year, to sidestep those accusations Congress granted the industry a slight increase in tax deductions and passed the Alternative Motor Fuel Act (AMFA) of 1988. The AMFA sought to incentivize the automobile industry to make vehicles that could operate (exclusively or flexibly) on ethanol or other alternatives like methanol and natural gas. In theory this approach could indirectly encourage more ethanol consumption. However, with the law's neutrality over alternative fuel choice and weak incentive structure left it up to automobile manufacturers to decide whether or not to pursue new engine designs for ethanol over some other alternative fuel. Dissatisfied, the ethanol industry pressed for more favorable regulation in the next administration.

By the end of the Reagan Administration, a new imaginary of ethanol as a clean air

technology had begun to emerge. Vice President George H.W. Bush chaired a Task Force of Regulatory Relief that recommended greater use of alternative fuels like ethanol, methanol and compressed natural gas. Reagan (1987, p. 857) explained the work of the Task Force in terms of the air quality benefits that alternative fuels provided:

> This may sound like a technical issue, but it has dramatic implications for virtually every aspect of American life. You see, used correctly these fuels can reduce pollution significantly, and the Task Force recommendations would allow States to include alternative fuels as a central part of their air quality attainment plans, if they so choose. This would prove crucial in helping a number of States avoid nonattainment sanctions and the imposition of other, more costly and intrusive regulatory burdens."

The arrival of President George H.W. Bush (1989-93) brought the industry greater political support and helped solidify a new imaginary that promoted ethanol as a clean air technology over other alternative fuels. During his presidential campaign, Bush had courted corn state votes; He vowed to make the expansion of domestic and foreign markets for farm products his top agriculture.[103] Nonetheless, Bush argued that farm subsidies and production controls constituted undesirable government intervention. As discussed in Chapter 3, production control policies have a contentious history in the US. They go back to the rise of corporatist ideology in the years before and after the Great Depression when they were proposed as a way to keep farm commodity prices high by restricting the quantities of crops planted by farmers. Corporate agriculture always opposed this approach, preferring instead that the state help them find new markets for their surplus product. This is exactly what Bush proposed: to find new markets for US agricultural commodities. To achieve this, Bush focused on two strategies: exporting more crops to foreign markets and expanding domestic markets for corn ethanol. In a Presidential debate against Dukakis, Bush (1988) proclaimed:

> We have a fundamental difference, approach on agriculture. He favors this supply maintenance or production controls… I believe the answer to the agricultural economy is not to get the government further involved, but to do what I'm suggesting. In the first place, never go back to that Democratic grain embargo, that liberal Democrat grain embargo that knocked the markets right out from under us and made Mr. Gorbachev say to me when I was here, how do I know you're reliable suppliers? We never should go back to that. And we ought to expand our markets abroad. We ought to have rural enterprise zones. We ought to move forward swiftly on my ideas of ethanol which would use more corn, and therefore, create a bigger market for our agricultural products. But let's not go back and keep assailing a farm bill that passed with overwhelming Democrat and Republican support…. The farm payments are going down because the agricultural economy is coming back. (emphasis added)

Once in office, the Bush Administration went to work to fulfill his promises to support corn ethanol production by casting ethanol as an "oxygenate" in the 1990 Clean Air Act Amendments (1990 CAAAs) (Martineau and Jovello, 2004). Oxygenates are a category of fuel additives created by the EPA that improve the amount of carbon monoxide emitted from automobile tailpipes in gasoline combustion engines. In this imaginary, ethanol promised to fulfill new regulatory requirements under the Clean Air Act Amendments of 1990 for cleaner

[103] The presidential election coincided with major US crop damage from drought (Johnson, 1988). In pre-election speeches and debates, Bush distinguished his assistance to farmers from his opponents. "A Bush Administration will help farmers export more crops, not force farmers to produce less," the Vice President said. "That is the major difference. Those who advocate stringent supply controls have been proven wrong before, and they are just as wrong today." "If I am elected President, and I really do believe I will be, the top agricultural priority of my Administration will be to expand farm markets, both domestic and foreign" (Boyd, 1988).

automobile tailpipe emissions. In essence, ethanol was imagined as a technological fix for carbon monoxide pollution. Regions that do not meet the National Ambient Air Quality Standards (NAAQS) set by the Environmental Protection Agency (EPA) are required by law to come into attainment. At the time, CAAA regulations stipulated that failure to the NAAQS standards for carbon monoxide required sub-national governments reformulate gasoline with oxygenates. Methyl tertiary-butyl ether (MTBE), a petroleum industry product, was the most widely available oxygenate product on the market. Ethanol producers pushed for an amendment to the regulation that would include ethanol as an acceptable oxygenate for carbon monoxide attainment.

The amendments passed easily in Congress, but controversy arose during the EPA rulemaking process over ethanol's vapor pressure, which made it a contributor to ground-level ozone (O3). During the EPA's rulemaking, studies revealed that ethanol blended in small amounts with gasoline contributed to ground-level ozone formation, a major air pollution category regulated by the EPA's NAAQS under the CAAA. To regulate O3, the EPA set caps on gasoline vapor pressure. Lower vapor pressure in gasoline formulations helped to reduce O3 formation during warm seasons. However, ethanol has higher volatility than gasoline. This means that when ethanol is added to gasoline ("gasohol") and used in combustion engines, it increases gasoline's vapor pressure. A higher vapor pressure would cause a greater amount of harmful chemicals to evaporate from gasoline. Specifically, there would be more combustion of the volatile organic hydrocarbons (VOCs) already present in gasoline, which are precursors to O3. Thus, although adding small amounts of ethanol to gasoline reduces carbon monoxide emissions, it increases gasoline's vapor pressure and results in more combustion of harmful VOCs. Blending ethanol with gasoline to reduce carbon monoxide posed the risk of contributing to more smog (O3) formation in the very places mandated to improve their air pollution.

Under the scrutiny of EPA rulemaking and litigation, the imaginary of ethanol as a clean air technology was called into question. Even though the CAAA of 1990 effectively redefined ethanol as an acceptable oxygenate to blend with gasoline as a way for subnational regions to improve their carbon monoxide pollution, parties to the EPA rulemaking procedure could not, or would not, circumvent the statutory requirements of NAAQS attainment. EPA rulemaking proceedings involve notoriously lengthy and often-contentious regulatory negotiation processes (commonly called a "reg-neg") between government regulators and other state officials, representatives of the auto and oil industries, oxygenate suppliers including ethanol producers, environmentalists and others. These stakeholders met to forge consensus on EPA regulations to help reduce the likelihood that such rules would be contested in court. Prior to the CAAA of 1990, gasohol (gasoline blended with ten percent ethanol) enjoyed a waiver from caps on vapor pressure to support the ethanol industry. However, this time, parties to the EPA reg-neg decided not to extend a waiver for ethanol, given that the primary goal of the CAAA to reduce ozone formation and their assessment of ethanol's overall performance indicated it would undermine the NAAQS (Reitze, 2001). Without a waiver for vapor pressure, the ethanol industry worried that they would be excluded from the reformulated gasoline market (Martineau and Jovello, 2004).[104] In April 1992, the EPA published their proposal, which ignited great controversy in Congress and the Executive Branch because it threatened to limit the market for ethanol.

[104] Oil refiners would not produce extra-low volatility gasoline to accommodate ethanol blends because they could easily (and more cheaply) blend their own MTBE oxygenate produce with gasoline to supply the needed oxygen for

Upon hearing the news of EPA's proposed rule, the Senate swiftly passed a resolution that the "sense of the senate" in passing the CAAA had been to support the ethanol industry by providing access to the oxygenate market. This was a rare move in response to the proposed EPA rules. Congress pushed the White House to reconsider its EPA's approach (Wald, 1992). The White House agreed, and tasked the EPA with finding a way to provide the ethanol industry access to the oxygenate market despite its shortcomings as a clean air technology (see Segal, 1993). Under the direction of the Bush White House, the EPA went back to the drawing board to amend its proposed rules (Reitze, 2001).

The controversy over ethanol as an oxygenate under the Clean Air Act Amendments of 1990 pushed the EPA into complicated technical territory, in which regulators created a technical fix to maintain ethanol as an acceptable oxygenate. Rather than waive the vapor pressure requirements for gasohol, which would likely not hold up in a legal challenge, the EPA had to find a way to offset ethanol's contribution to higher emissions of VOCs. The EPA sought to develop a methodology for determining the emission levels of various gasoline-oxygenate formulations for the entirety of the 1990 model-year vehicle fleet. The methodology provided a way to model VOCs and other toxic emissions based on a fuel content of oxygen, benzene, heavy metal, aromatics and other chemical properties (Martineau and Jovello, 2004). This model enabled the EPA to see whether a particular fuel offered trade-offs between various air toxics, leading the EPA to its final solution for maintaining ethanol's qualification as an oxygenate. In February 1993, the EPA issued another proposal in which it added a new performance standard to the CAAA under Section 211(c) for required reductions of another pollutant: nitrogen oxides (NOx). Studies showed that NOx emissions decrease in proportion to the increase in content of ethanol blended with gasoline (See Massum et al., 2013). Thus, by adding a requirement that gasoline meet NOx reductions, the EPA created a technical fix that enabled their models to weigh ethanol's contribution to air pollution more favorably. Essentially it offset ethanol's increase in VOCs with its decrease in NOx.

The Clinton Administration (1993-2001) abandoned this approach to maintaining the ethanol imaginary as clean air technology (the NOx technical fix described above) and instead proposed a new imaginary of ethanol as a renewable fuel, rather than a clean fuel. The Clinton EPA explained that the Bush EPA plan was unworkable (Martineau and Jovello, 2004). Rather than try to offset VOC emissions with NOx emission using complicated methodologies, the Clinton EPA's final plan released in August 1994 issued a requirement that 30 percent of oxygenate requirement for all reformulated gasoline must come from "renewable oxygenates" (Martineau and Jovello, 2004). A caveat to this requirement was that during summer months, fuel blenders could only use oxygenates that did not cause an increase in gasoline volatility. This meant ethanol would only qualify in the winter. To maintain market share in the summer months, ethanol producers could sell the ethanol derivative ETBE (Ethyl Tertiary Butyl Ether).

The new imaginary of ethanol as a renewable fuel encountered opposition from those who participated in the EPA regulatory negotiation, especially environmentalists, the petroleum industry, and the State of California. Environmentalists took issue with the renewable

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the CAAA regulation. This approach allowed them to meet the regulation without having any of the volatility problems presented by blending ethanol with gasoline.

requirement based on ethanol's pollution profile as a contributor to ground-level ozone (O3). The petroleum industry challenged the EPA's "renewable requirement" in court in order to preserve the market share for MTBE, its own oxygenate product. The requirement to blend ethanol would also increase their costs of producing gasoline for consumers. This was also a major concern for the State of California given its had urban areas that were unable reach attainment for O3. In American Petroleum Institute and National Petroleum Refiners Association v. Environmental Protection Agency (1995), the court found that the EPA lacked the authority to dictate what kind of oxygenate states should blend to meet CAA requirements. The courts eventually struck down the "renewable requirement," ruling that the EPA lacked the authority to dictate blending requirements such as the renewable requirement that were not explicitly set forth in the law.[105]

4.4 Ethanol as the platform of the low-carbon "Bioeconomy"

Despite renewing subsidies for corn ethanol, President Clinton (1993-2001) was less outspoken in his support for the ethanol industry compared to his predecessor (Reitze, 2001). Instead, Clinton focused on curbing air pollution and climate change by trying to tighten fuel efficiency standards (Sperling, 2001). When Republicans gained majority control of Congress in 1994, they banned the executive branch from tightening fuel standards and defunded Clinton's program for fuel-efficient cars. The Administration refocused its attention on developing ethanol fuels and ethanol vehicles, which had support in Congress and the auto-industry. Yet corn ethanol was becoming more controversial amid new findings that ethanol-gasoline blends would have a negative energy balance and a negative impact to air quality (see US Congress, 1994).

Rather than pursue corn ethanol as a clean air technology, the Clinton Administration calibrated ethanol to its larger economic and foreign policy goals to improve the US balance of trade. In 1997, the President's Committee of Advisors on Science and Technology (PCAST) released a report presenting cellulosic technology as the lynchpin of a future "global bioeconomy" dominated by US companies and technologies, in which ethanol was only one among several successful cellulosic products (Holdren, 1997). In this imagined future, US biosciences would contribute to a new era of industrial development by spurring a global transition from petroleum-based products to bio-based products, beginning with cellulosic ethanol (National Academy of Sciences, 2000). Like corn mills and petroleum refineries, biorefinery complexes would yield industrial chemicals, liquid fuels, food products and non-food materials—eventually satisfying up to 90 percent of US petrochemical consumption and up to half of US liquid fuel needs in a more sustainable fashion (National Research Council, 2000). By leading the way for a "cellulosic bioconversion industry," the US would "create domestic industrial expertise in both processing and feedstock production that could be transferred to other countries and would benefit the US economy" (National Research Council, 1999, p. 13). To lay the groundwork for the bioeconomy, Clinton signed the Biomass Research and Development Act ("Biomass R&D Act") in 2000.

[105] In American Petroleum Institute v. Environmental Protection Agency, 52 F.3d 1113 (D.C. Ct. App., 1995), the court found that the EPA lacked the authority to dictate what kind of oxygenate states should blend to meet CAA requirements. See also the challenge California brought against the EPA over the use of ethanol as an oxygenate in *Davis v. EPA* 336 F.3d 965 (9th Cir. 2003).

Industrial policy under the George W. Bush Administration (2001-09) reinforced the state's pursuit of cellulosic technology by providing industrial policies of a "harder" variety. Emboldened by rising oil prices that the President's national energy advisors heralded as "the most serious energy shortage since the oil embargoes of the 1970s" (NEPDG, 2001), the government finally instigated an ethanol consumption mandate similar in the Energy Policy Act of 2005 ("the 2005 EPAct"). The law created the Renewable Fuel Standard (RFS), which requires the EPA to mandate a certain number of gallons of renewable fuel (primarily ethanol) blended with gasoline every year. Two years later, Congress passed the Energy Independence and Security Act of 2007 ("EISA"), which set more ambitious consumption targets for ethanol within the RFS, but importantly differentiated traditional corn ethanol from more "advanced biofuels" (like cellulosic ethanol) based on the amount of greenhouse gas (GHG) emissions avoided by each fuel compared to gasoline. In effect, the 2007 EISA carved out a special mandate for low GHG emitting cellulosic biofuels that rationalized corn ethanol not as an end in itself, but as an essential stepping-stone to the cellulosic bioeconomy.

Building further on Clinton's platform for improving America's competitiveness, Bush announced a larger strategy to keep America "the most innovative nation in the world" (Bush 2007; NAS, 2007), which brought forth the 2007 America COMPETES Act. The law established the Advanced Research Projects Agency for Energy (ARPA-E) in the Department of Energy (DOE). As the state's venture-capitalist for the alternative energy sector, ARPA-E would target commercialization of cellulosic technology (National Research Council, et al., 2009, p.222). In addition, the Food, Conservation, and Energy Act of 2008 (the "2008 Farm Bill") provided loan guarantees to cellulosic biorefineries and created the USDA Biomass Crop Assistance Program to support farmers that transition to growing cellulosic feedstocks. With the ethanol consumption mandate in place, the Blender's Credit and tariffs for ethanol ended have finally been removed (as was the original intent of Carter's 1980 Energy Act) under the Obama Administration (2009—present). The Obama White House continued to promote the cellulosic bioeconomy through its "National Bioeconomy Blueprint," which focused on fostering bioeconomy entrepreneurs with R&D funding for "bioinventions" (White House, 2012).

Throughout the Clinton and Bush Administrations, US political culture became more accommodating to state intervention under the banner of "competitiveness," inscribing stronger market-push and -pull policy programs to bring the various components of the cellulosic bioeconomy into existence. Cellulosic feedstock production will be rooted in a select set of monocultures. Despite some early interest in returning degraded agricultural lands into "mixed" prairie planted with cellulosic perennial grasses and developing municipal solid waste supply chains, the state envisions building new cellulosic supply chains from agricultural residues such as corn stover (left over corn stalks) and monoculture crops including perennial woody crops (e.g. poplar, willow, eucalyptus), and new monocultures dedicated to energy production such as sorghum and perennial grasses (e.g. switch, bluestem, Indian, miscanthus, sugarcane) (US DOE, 2011). The public sector will provide the R&D inputs needed up until the deployment stage for new feedstocks and conversion technologies, and the private sector will bring these technologies to market supported by loan guarantees and extension services. Biorefineries will enroll farmers in new supply chain relationships to source the monoculture that best fits their cellulosic-based business model, and farmers will develop the agronomic skills needed to implement land use changes driven by demand from biorefineries, which in turn respond to consumer demand driven

the ethanol mandate.

Yet commercialization has remained the single biggest barrier to scaling cellulosic production systems (see Kelsi et al., 2011; Wyman, 2007).[106] Laissez-faire logic limits government-led technology development to pre-commercial phases. Legislation has provided R&D inputs for the bioeconomy, whereby the US's decentralized public innovation system includes executive agencies—each with their own R&D budgets—more than a dozen national laboratories at the Department of Energy, numerous research universities, and private sector collaborators, all of which steer technological development without "picking winners." For example, the Biomass R&D Act was designed to support demonstration projects to help identify commercial opportunities, but left the question of how cellulosic technology would take root and grow the bioeconomy into the private sector, despite policy reports warning that market forces would not be sufficient to pull cellulosic innovations from the lab to the market (see NRC, 1999). ARPA-E operates under similar constraints (Stine, 2009).[107]

Farmers remain reluctant to make risky investments to establish new crops without strong market-signals from cellulosic producers, and entrepreneurial decision-making is hampered by a lack of information about feedstock costs, actual available tonnage, and costs to collect, handle, preprocess, store, preserve, or transport biomass to the biorefinery (Perlack et al., 2011). The limits of the Renewable Fuel Standard—the stepping-stone to the bioeconomy—are increasingly evident as the ethanol consumption mandate bumps up against the EPA's E15 "blend wall." Although US automakers manufacture FFVs that can run on much higher ethanol-gasoline blends (i.e. E85), fueling infrastructure is extremely limited, inhibiting greater ethanol consumption.[108]

Thus, despite strong signals about what kinds of cellulosic production systems are possible, the US cellulosic imaginary does not specify how implementation will take place beyond the set of supply-side and demand-side market incentives that enable "a thousand flowers to bloom." As Schrank and Whitford (2009:535) observe, faced with an innovation ecosystem that plays host to relatively large populations of several different species, US industrial policy makers ensure that "they will not back the wrong horse—or that if they do, the consequences are unlikely to be tragic." This is arguably the strength of the US approach to industrial policy. Yet, the US imaginary proposes that a complex array of changes occur in the current ethanol supply chain and landscape, leaving some industry actors to assert that what is needed from the government is not more R&D funding, but a coordinative mechanism to help reduce commercialization timelines.[109]

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[106] As of this writing, about 70 cellulosic projects (mostly pilot plants) are under way in the US, reflecting billions of dollars of public and private investment (Renewable Fuels Association, 2013). However, with only 25,000 gallons of cellulosic ethanol produced in 2012, the EPA's 2013 mandate for 10 million gallons of cellulosic ethanol will not likely be fulfilled (Wald, 2013).

[107] Arun Majumdar, then Director of ARPA-E, suggested at the ARPA-E Annual Conference in Washington, D.C. on March 2, 2010, the creation of a "Technology Push Office" and a "Technology Pull Office" could move cellulosic energy technologies through the pipeline, but this plan has not materialized.

[108] The EPA's "blend wall" limits the amount of ethanol sold at the gasoline pump to fifteen percent ethanol based on what levels of ethanol are considered safe for all engines.

[109] Industry advocates have recommended an "Institute of Industrial Commercialization" that is dedicated to reducing commercialization timelines in the US (See Lane, 2012)

Chapter 5 Sweetening the Cerrado, Cars, and Carbon: Ethanol imaginaries and policymaking in Brazil

Ethanol proponents in industry and government often refer admirably to the Brazilian experience with ethanol as a lesson in expedient policymaking for alternative, climate-friendly energy development (see NRC, 1999). The standard story is as follows. The fuel crisis precipitated by the 1973-4 quadrupling of crude petroleum prices by the OPEC countries presented an opportunity window for Brazil's struggling sugarcane producers. In 1975, the government launched the National Alcohol Program ("ProAlcool") to blend gasoline supplies with ethanol for domestic consumption (Barzelay, 1986). From its inception in 1975 to when it officially ended in 1991, ProAlcool replaced approximately 250,000 barrels of oil per day with ethanol—one-half the gasoline that otherwise would have been consumed by automobiles (Goldemberg and Macedo, 1994). The legacy of ProAlcool continues to linger in contemporary approaches the state pursues to support the ethanol industry.

In this chapter, I argue that a closer look at the Brazilian ethanol experience within its broader historical and cultural contexts reveals that the National Alcohol Program of Brazil ("ProAlcool") did not materialize solely in response to oil price shocks in the 1970s. Rather, it was a contentious policy response to a complex set domestic policy problems involving tensions between the sugar industry and the state-owned oil company and growing public disapproval of the military government's macroeconomic and microeconomic governance of the Brazilian economy. Furthermore, a historical examination of the Brazilian ethanol experience also reveals a number of patterns in the evolution of Brazil's political cultures of economic governance. Compared to the US, Brazilian political cultures of economic governance have been defined by a lasting ideology of corporatism. This ideology has institutionalized in Brazil's tradition of the Estado Benefactor, in which the state plays a paternal role in organizing the economic life of its key interest groups. Although neoliberal ideology has not fully undermined Brazil's corporatist approaches to economic governance, the Brazilian state has creatively fused a number of neoliberal governance practices and institutions with its earlier economic governance traditions.

In this chapter, I first provide a brief history of the development of Brazil's ethanol sociotechnical system. I then turn to examine three principal sociotechnical imaginaries that have emerged from the state to describe the role that ethanol will play in Brazil's future. These include the imaginary of diversified ethanol production, sweeter cars and carbon, and finally competitive cellulosics in the Cerrado. In my analysis of each, I attend to the interactions between ethanol imaginaries and Brazil's evolving political culture of economic governance.

5.1 A short history of the ethanol sociotechnical system in Brazil

The history of ethanol in Brazil is part of a much longer history of sugarcane, in which a powerful class of usineiros (large sugarcane mill owners) has come to dominate sugar-ethanol production. In this short history, I provide a brief overview of the rise of the usina (sugarcane mills) model of sugarcane production in the Center-South region of Brazil, along with major socio-natural and socio-technological developments that have shaped the trajectory of ethanol production, remains tightly linked to sugar production in Brazil.

Portuguese colonizers brought sugarcane to their new colony from Portugal in the early 16th century, with the intent of becoming world's largest producer of sugar. The Brazilian model of sugarcane production that developed between the 17th and the 20th centuries was resource-intensive, compared to sugarcane production systems in colonies where producers were quicker to adopt major technological innovations like the application of manure as fertilizers and the use of steam power in the 19th century (Rogers, 2015). However, what made all colonial sugarcane production models profitable was the institution of slavery in both the Americas and Europe (Edel, 1969).

With the abolition of slavery in 1888, came a shift in the model of sugarcane production (Baer, 2008). Large new mills called usinas used steam-power to deliver cane by railroads and grind cane into pulp. This enabled higher-yielding processing activities to concentrate in one place, surrounded by plantations run by a rural workforce. Initially, the imperial government incentivized the creation of production systems modeled on the centrales (sugar plantation-mills) of Cuba, in which large central mills buy cane from independent growers (Baer, 2008). However, in Brazil, growers could not meet the usinas' demand for consistent supplies and the usinas began growing cane on their own (Rogers, 2015). Because of their focus on higher-value industrial processing, usinas acquired land to produce cane, vertically integrating their own production processes and absorbing many smaller growers in the traditional planter class. This helped solidify a division of labor between smaller sugarcane growers and economically powerful usinas. In the Northeastern state of Pernambuco, the growth of usinas was the greatest from the 1880s to 1910, when more than sixty usinas were established in the Pernambuco sugar zone. The growth of usinas in the states of Rio de Janeiro and São Paulo accelerated after the 1920s (Rogers, 2015).

São Paulo usinas' share of production began to overtake those of northeastern usinas in the 1930s. In the 1920s, under attack from mosaic disease, São Paulo's sugarcane producers mounted a technologically advanced response to containing the disease compared to their northeastern counterparts. The technological superiority of São Paulo producers was due in large part to the migration of wealthy coffee producers in the Center South into the sugarcane industry to escape crisis in world coffee market (Rogers, 2015). By the 1950s, the sugar industry had expanded rapidly in the State of São Paulo, outpacing production in Pernambuco.

Under President Getúlio Vargas (1937–1945) and his Estado Novo regime, Brazilian usinas became producers in a strategic export sector. This began with the founding of the Sugar and Alcohol Institute (IAA) in 1933. The IAA functioned as a state agency charged with regulating the national market for sugar. The IAA's primary roles were to set production quotas for each usina, to buy sugar from usinas at a price that protected the industry from price declines, and to provide public loans for infrastructure improvements (Gordon-Ashworth, 1980). By the 1960s, under the auspices of the IAA, sugar became a strategic export sector for Brazil.

In the early 1970s the military government, which had wrested control of the state from Vargas in the Revolution of 1964, launched a modernization scheme designed to intensify production (Barzelay, 1986, p. 134). The centerpiece of this initiative was the creation of the National Program for the Improvement of Sugar Cane ("Planalsucar"), which provided the industry with critical plant breeding research and extension support, and the merging of

uneconomical sugar mills with large-scale capital-intensive operations. Planalsucar supplied growers with cost-cutting biological control systems and pest- and disease-resistant sugarcane varieties with increasingly higher sucrose content (Hall et al., 1993; Wilkinson and Sorj, 1992).

Modernization helped to concentrate private ownership among usineiros (wealthy sugarcane grower-millers' operations). Within Sao Paulo, fornecedores (small-scale independent sugarcane producers) found it difficult to compete with Sao Paulo's elite agricultural families who had established large-scale operations of integrated sugarcane growing and milling operations. Moreover, as land prices in areas surrounding sugarcane plantations have increased substantially over the years, many fornecedores have been unable to resist acquisition by larger landowners and mills.

The decline of fornecedores accelerated a process of capital and land concentration in the Center-South region that enabled economies of scale that have transformed the sugarcane production landscape into a large interconnected area of densely grown sugarcane monocultures. The reduced biodiversity has resulted in a higher incidence of pests, which have largely been managed through the application of agrochemical inputs (herbicides, insecticides and fungicides). Usinas' focus on achieving the highest possible yield at the lowest cost has led to inter-sectoral coordination to develop a number of higher-yielding technologies to manage high susceptibility to pests and disease. In particular, usinas have benefited from the innovations produced by Copersucar (Cooperativa Central does Proutores de Açúcar do Estado do São Paulo/Central Cooperative of Sugar Producers of the State of São Paulo)—one of two dominant sugar producer cooperatives that formed in the mid-1960s.[110] Copersucar mobilized its collective power to create an agricultural research arm that has provided lower-impact fertilizer application for pest management, biological pest controls, pest resistant cane varieties, plant genetics, high-yielding pest resistant sugarcane varieties, and experimental irrigation systems (Nunberg, 1986). In recent years, has developed integrated pest management techniques and many usinas in Sao Paulo have replaced pesticides with biological pest controls systems. Greater producer control over agricultural R&D has led to some advantages in terms of decreased dependency on costly inputs sold by large agrochemical firms and the use of fewer petrochemicals through integrated pest management techniques. Compared to other monocultures, Brazilian sugarcane has been less input-intensive.

Producers have importantly relied on the continual development of Copersucar technologies, which have helped São Paulo usinas to maintain the large monoculture cultivation systems that are underlie their dominance in the sector. However, the monoculture production model has increased industry's footprint overall. For example, despite integrated pest management systems, herbicide leaching from sugarcane crops in São Paulo has long been linked to water contamination in extraction and recharge areas of the Guaraní Aquifer—the largest freshwater aquifer in South America, which supplies drinking water to 500 cities and towns throughout Brazil and is a water resource shared by Paraguay, Uruguay and Argentina (Wilkinson and Sorj, 1992; Nunberg, 1986). In smaller-capacity distilleries and plantations, the

[110] In addition, the government-run Institute for Sugar and Alcohol (IAA) supervised funding to Copersucar Technology Centre (CTC), the non-profit research arm of sugarcane producers in São Paulo, which implemented a plant breeding program of similar magnitude to Planalsucar and improved industrial engineering (Wilkinson and Sorj, 1992).

use of agrochemical inputs can be more easily minimized. In addition, since 1994, the Copersucar Technology Center has increasingly focused on producing transgenic varieties, which pose a different set of socioeconomic and environmental risks. Monoculture cane has also negatively impacted agricultural livelihoods by usurping food crops. As a result, the Center-South's self-sufficiency in food production has diminished, creating a periodic need to import large quantities of basic food products to the region. In smaller-capacity distilleries and plantations, the use of agrochemical inputs is more easily minimized.

Usina operations have also transformed a once permanent labor force of subsistence farmers into a labor market of temporary wage laborers relying on seasonal cane harvest. Rural worker unions were legalized in the 1960s, at the same time that sugar production increased as a result of the Cuban Revolution (Rogers, 2015). However, the sugarcane modernization effort has undermined union organizing. Research shows that sugarcane laborers have less employment security and are prone to a number of workplace risks, including human rights abuses, exploitative management practices, and high incidence of drug use to sustain workplace depression and injury (de Andrade and Miccolis, 2011). Many of these laborers are migrants who often suffer from even less protections and riskier working conditions compared to their native counterparts. Sugarcane laborers experience high environmental exposures to pesticides and atmospheric pollution from the burning of sugarcane for harvesting, which is linked to high incidences of respiratory disease.[111]

It is against this backdrop Brazilian ethanol production emerged. Ethanol production was already a customary bail out by the 1960s before the official National Alcohol Program (ProAlcool) decreed by President Geisel in 1975. In the 1960s, Brazilian sugar producers began to struggled against a sharp decline in international sugar prices. Under the Estado Novo, President Getúlio Vargas (1937–1945) required blending small amounts of ethanol with gasoline to utilize excess sugar production. Through a state agency, the Sugar and Alcohol Institute (IAA), the government set production quotas, sugar and ethanol prices, and fuel blending requirements to mitigate impact of the dynamic forces of the world market on Brazilian sugar industrialists (Johnson, 1983). Thus ethanol in Brazil did not originate as a strategy for gasoline displacement, but as one of many tools used to address the periodic problem of sugar overproduction in the 20th century.

When sugar prices dropped suddenly in 1975, São Paulo usineiros faced a serious crisis of overcapacity. That year, the Ministry of Mines and Energy and the Ministry of Industry and Commerce proposed authorizing construction of annexed distilleries such that more sugar mills would have the capability to switch to ethanol production whenever sugar prices were low. The subsequent fuel crisis, precipitated by the 1973 Arab Oil Embargo, provided additional—albeit secondary—justification for the proposal (Barzelay, 1986, p. 141). President Geisel decreed the creation of ProAlcool in November of 1975 as a solution to a number of national macroeconomic and macropolitical problems. The official rationale for ProAlcool centered on saving the nation's

[111] For example, burning sugarcane also releases ozone-producing nitrogen.

foreign exchange linked to Brazil's imbalance of trade problem.[112] Early on, the primary motivation was to help the domestic sugar industry deal with the effects of crashing world prices on sugar, to maintain rural employment in the sugar sector, and to make use of investments already sunk into upgrading sugar infrastructure. Ethanol production offered a way to prepare for the possibility that world sugar prices would remain low. The price of oil became a secondary rationale that strongly reinforced the original proposal written by the Ministry of Mines and Energy (MME) and the Ministry of Industry and Commerce (MIC). When the 1973-74 oil price shock hit Brazil, the Council for Economic Development (CDE) began developing an ethanol policy to substitute oil imports for domestic ethanol (Barzelay, 1986, p. 139-142).

Usineiros and the IAA, the state agency in charge of managing sugar production, exports and collecting revenue from trade, supported the expansion of ethanol production capacity via annexed distilleries. Annexed distilleries would give sugar mills the flexibility to switch to ethanol production whenever sugar prices were low, but also ensure that sugar producers could easily switch back to making sugar for the world market when prices rose again. This strategy of flexibility for dealing with expected market instability reflected Brazil's historical sugar experiences, and would later be mirrored in the consumer markets by the creation of "flex fuel" vehicles capable of using both oil and ethanol, according to prevailing market prices for both.

Ethanol production and consumption expanded rapidly between 1979 and 1985 under Brazil's highly regulated National Alcohol Program (ProAlcool). However, Ethanol production and consumption stagnated in the late 1980s and 1990s, as oil prices collapsed amid Brazil's process of economic liberalization. Beginning in the late 1990s and early 2000s, the industry embarked on a new era of expansion. Yet, as the below analysis shows, the ethanol industry owes its growth elixir not only to the return of high oil prices, but also to the persistence of a tradition of state coordination despite structural adjustments to "open" and decentralize Brazilian economic sectors for increased competition in international markets.

5.2 The ethanol imaginary of diversified production

The first state imaginary for ethanol in Brazil emerged under President Ernesto Geisel (1974-1979) in the form of an outorga: a gift or grant from the state's political leaders to its corporatist body in the form of an ethanol development strategy geared towards the goal of sector-specific income redistribution.[113]At the center of this imaginary lay a new, diversified economic geography of ethanol production. Brazil's ethanol value chain would comprise not only new ethanol distilleries annexed to the old sugar mills of wealthy sugarcane plantation owners (usineiros) predominantly located in the state of São Paulo; it would also include mini-distilleries producing ethanol from cassava (also known as manioc in Brazil), grown by poor subsistence farmers in the Cerrado biomes of Brazil's Midwest region. This imaginary proposed to spread the benefits of ethanol development to the rural poor by creating a new class of manioc-ethanol suppliers and producers, as well as expanding farm labor opportunities through

[112] In 1975, Brazil's external debt was rising, foreign exchange reserves were falling, and Brazilian exports were not performing as expected, meaning the capital resources flowing back in to the country were insufficient to cover the balance of payments deficit.

[113] As discussed in the previous section, the *outorga* is a form of state power in which state leaders generously bestow a gift or a grant to one or more of its corporatist constituencies in the form of new laws or other forms of governance—without said constituency demanding such a gift.

the ethanol production landscape. In effect, by creating new constituencies with stake in ethanol, the state could validate the tradition of Estado Benefactor ("the Benefactor State") at a time when this tradition was increasingly be called into question.

Below I first discuss the Estado Benefactor as an influential tradition within Brazil's genealogy of various political cultures economic governance. I then describe how the imaginary of diversified ethanol production emerged during the 1970s. I look closely at how this imaginary evolved over the course of the development of ProAlcool, which grew from a primary focus on the IAA (the state agency in charge of setting sugar production quotas, overseeing exports, and collecting state revenues) and Copersucar (the powerful cooperative of São Paulo-based usineiros and the unofficial representative of private sugar interests in the country's Center-South region), local manufacturers of mill and distillery equipment, to include the rural poor. I then explore the various factors that contributed to the dissolution of this imaginary. Despite efforts to mold ProAlcool into a parallel strategy for addressing rural economic inequality, it ultimately concentrated on traditional private sugar interests.

Corporatist Ideology and the Estado Benefactor Tradition

Brazil's corporatist ideology has given form to multiple traditions of economic governance in Brazil, one of which is the tradition of the Estado Benefactor. The term corporatism has been plagued with ambiguity in academic debates given its multi-purpose usage as a concept. Yet the basic feature of corporatism as an ideology is the belief in the continuous presence and structured participation of interest groups in determining political economy. Most often state-led bargaining and concentration assume central importance (Molina and Rhodes, 2002). In Brazil, corporatism has been a dominant and resilient ideology throughout the country's political history. As McDonough (1981) explains, "it has rendered politicians vulnerable to domination by elites who are impatient with pluralistic bargaining, and vulnerable as well to the indifference of the Brazilian public" (p. 237).

The tradition of the Estado Benefactor ("the Benefactor State") took shape under the Estado Novo (the "New State") regime of President Getúlio Vargas (1937–1945). In a Brazilian conceptualization of this tradition, a neutral state sits atop society, maintaining the distance needed to serve as the 'paternal' head of a corporatist body that goes unscathed by the clash of interests. Its key capacities relate to its ability to guide the body's various private organs, especially labor, in order to balance national economic development with questions of distributive justice. Among its core practices is the use of the outorga: a "gift" or "grant" from Brazil's political leaders or government to multiple organs of its corporatist body (French, 1991, p. 29-30). The outorga emerged in direct response to the "anti-Getulista politicians" (against the Vargas Regime) and Brazilian industrialists who had denied the state's attempt to address the labor problem. The outorga during the Vargas regime commonly took the form of a labor law or some other kind of state-led negotiation that aimed to find mutual benefits for both the industrial bourgeoisie and the working class, with the goal of precluding violence (French, 1991, p. 27). The Vargas state apparatus attempted to organize the working class and its powerful industrial employers into a cross-class alliance that allegedly embodied collective national interest (Skidmore, 1988).

Importantly, an outorga is assembled without particular demands from the very constituents the state intends to benefit from it. As such, the outorga represents the state's preemptive ability to exercise autonomy by managing the economic and political diversity of its constituents.[114] It stands in contrast to a bottom-up system of interest-group politics, whereby for example, in the domain of labor relations, workers would struggle for improved conditions and wages, pushing for state intervention and institutional change on their behalf. With an outorga, labor relations are top-down: the state anticipates the needs of labor and negotiates with the industrial elite on labor's behalf.

Thus, the outorga produces an artificial quality within the tradition of the Estado Benefactor—what French (1991, p. 29) calls the "myth of the outorga." The state believes one of its great virtues is to perceive problems ahead of time. Yet, its inherently authoritarian and state-centered perspective undermines its ability to manage diverse national interests. In the realm of labor politics, critics of the outorga argue that this state-centered perspective on labor relations entails the deradicalization of the working class and the suppression of progressive movement formation (French, 1991, p. 32-33). In effect, what is achieved by the outorga is the creation of a cooperative working elite to safeguard capitalist social relations by "taking the winds out of the sails of communism" (French, 1991, p. 32). Defining "the national interest" has thus been a highly contested practice in Brazil, given the disparity in political power among the rural poor and urban labor on one side, and the agricultural and industrial elite on the other.

Within the sugar sector, the creation of the Sugar and Alcohol Institute (IAA) in 1933 under President Vargas can be understood as an outorga. The IAA was the first of many similar institutions created to carry out the Vargas strategy of import-substitution industrialization (ISI) at the sectoral level (Barzelay, 1986, p. 147). Through ISI, Vargas sought to reduce dependency on foreign imports using a combination of trade tariffs and production quotas (Schrank and Kurtz, 2005; Skidmore, 1988). Sectors with the greatest comparative advantage were state-owned, and the private sector benefitted from the public provision of cheap inputs from these state-owned industries as well as price support policies (Amann and Baer, 2005). The IAA fulfilled many of these functions for Brazil's sugar producers. As described in the previous sub-section, its primary roles included setting production quotas, guaranteed purchases of sugar, investments in technological innovation for sugar cultivation and processing, price supports, and public loans for infrastructure improvements.

In the case of the IAA, the myth of the outorga appeared in the state agency's inability to represent fornecedores (small-scale independent sugarcane producers) and sugarcane laborers. The IAA's modernization efforts helped to concentrate industry power among usineiros at the expense of other organs of the corporatist body. For instance, when sugar prices were high, the IAA set higher quotas, enabling fornecedores to produce at their full 60 percent quota. However, the IAA acquiesced to the usineiros' political maneuvering to undermine the fornecedores. Usineiros convinced the IAA to temporarily suspend the quota, which enabled usineiros to

[114] President Vargas's labor minister, in describing the state's preemptive ability to anticipate interest group demands, suggested that the Presidency was like an Indian in a US movie, who places his ear to the ground, and upon doing so "felt the clattering of hoofs of the social problem and tried to find ways to solve it—perhaps out of a bourgeois tendency had, to avoid more serious crises" (French, 1991, p. 30).

expand their operations to meet export demand, destabilizing fornecedores' positions in the sector, leaving many of them unable to resist acquisition by usinas.

The military government wrested control of the state from the Vargas dictatorship through the Revolution of 1964. The military bureaucracy aligned state and society under a more traditional corporate ideology. As the most powerful corporate monopoly in Brazilian history, it developed the capacity to drive economic growth by efficiently responding to sectoral interests, with the ultimate goal of moving the country from the periphery towards the core of the capitalist world system (Evans, 1979). Ambitious state-led modernization projects driven by ISI policies led to rapid industrial expansion and modernization, producing the so-called "Brazilian Miracle" (Evans, 1979) However, as the Brazilian Miracle faded, the military government struggled to maintain legitimacy in the face of mounting public impatience with its slow transition to a fully functioning democracy. In order to see the transition through, the military government had to maintain legitimacy by shedding its ties to the repressive national police and torture network, controlling subversive leftist factions, and maintaining high economic growth (Skidmore, 1988, p. 157-163). As the section below shows, although the Vargas regime had fallen, the tradition of the Estado Benefactor remained useful to the military dictatorship, especially the outorga as a mechanism for promoting more equitable economic development. Moreover, later sociotechnical imaginaries of ethanol have also drawn upon the logic of the outorga.

An ethanol imaginary emerges

The imaginary of diversified ethanol production began to take shape under the Council for Economic Development (CDE), after President Geisel decreed the creation of the National Alcohol Program (ProAlcool) in November of 1975. At this time, there was very little material support for an ethanol imaginary that was separate from sugar. The technology to produce alcohol-powered cars did not yet exits and there were no dedicated ethanol-only production facilities. In this context, the CDE established a task force to specify the future contours of the ProAlcool. By consulting with various state actors on how a national ethanol program could impact various Brazilian stakeholders, a re-interpretation of ProAlcool began to form around its purpose as an oil import substitution program (Barzelay 1986, p. 140-142). With a new policy frame that was not focused primarily on helping domestic sugar interests, leaders of the Ministry of Industry and Commerce (MIC), the Ministry of Agriculture (MA), and the National Council of Technologic Research (CNPq) insisted that the country's ethanol production network develop around a second raw material source: manioc, a tuber also known as cassava.[115] These ministries saw cassava as a way to provide economic opportunities to the rural poor without causing conflict in other crop production systems: the crop was already widely produced in a variety of agroecological systems.

Because of cassava's ability to grow easily in acidic soils, the Ministry of Agriculture viewed cassava-ethanol production as part of a larger vision of developing next agricultural frontier: the Cerrado biome. Manioc-to-ethanol production chains promised the benefits of ethanol development spread to smallholders in the Cerrado region, as well as usineiros in the Center South. The Ministry of Agriculture and other saw cassava-ethanol as a source of new

[115] Cassava is a starchy root, most commonly grown as a subsistence crop by poor tenant farmers and indigenous peoples in Amazonia. The vast majority of cassava is transformed into cassava meal.

income that could help reduce economic inequality in Brazil's rural economy. At the time, more than half of Brazilians remained engaged in agriculture, most of who were landless agricultural workers (Evans, 1974).

Cerrado was initially a development site targeted by the land reform movement of the 1960s. When the Military assumed power, it took control of the government and developed agricultural modernization plan, consisting of series of development policies that provided credit and other subsidies to large producers oriented to export of commodity crops soy, rice and cotton (See, Wolford, 2008). This Midwest region of Brazil had been inhospitable to cultivating commodity crops due to its acidic soils and partially hilly terrain and thus was not part of Brazil's ISI strategy. However, a number of programs under the military regime continued to consider how the Cerrado may be developed as the next agricultural frontier. For example, the POLOCENTRO (Development Program for the Cerrado) established in 1975 aimed to help initiate Cerrado land clearing, production, commercialization, capital goods, acquisition, harvesting. The PROTERRA land redistribution program of the 1970s financed smallholder families from Southern Brazil to settle in Mato Grosso, a state containing Cerrado biome. Other these plans included programs to support manioc and a variety of subsistence crops, as strategies to support small holder agriculture and to protect local soil conditions.

The Ministry of Agriculture's vision of income redistribution projected a version of state authority that countered public critiques of the military regime. At the time, multiple factions of society were dissatisfied with the limits of Brazil's ambitious state-led modernization programs. Such programs had produced the so-called "Brazilian miracle" in preceding decades. But the "Brazilian miracle" was now on the decline, due in large part due to the fragility of Brazil's ISI strategy in face of the international debt crisis (Saad Filho, 2010). ISI-generated wealth had concentrated among the industrial elite and nascent middle class without reaching the majority of the "The 80 Million" majority who subsisted on a standard of living among the lowest in Latin America (Evans, 1974). The military regime began to promote greater microeconomic interventions (Barzelay, 1986: 147; Codato, 2006), in which the state would apply the tradition of Estado Benefactor to sector-specific developmental strategies.

Faced with these pressures, President Geisel endorsed an ethanol imaginary that would address multiple problems, including reducing high oil prices, generating economic benefits for sugarcane workers and producers, reducing economic inequality, and stimulating indigenous technological innovation in the automobile and capital goods industries. A future bifurcated ethanol value chain would validate the tradition of Estado Benefactor, in which the state proved its capabilities in negotiating more equitable microeconomic growth, beyond the macroeconomic management that brought about the Brazilian Miracle.

Bifurcating the economic geography of ethanol would depend how the state allocated power over ethanol production and marketing. The President maintained control over ethanol production quotas through the CDE, which determined the legal amount of sugar to convert to ethanol (Barzelay, 1986, p. 166). However, the question remained of which entity would control ethanol marketing. Petrobrás, Brazil's state-owned oil company, proposed itself as a natural fit to be the sole purchaser of ethanol. Because it held a monopoly over the country's liquid transportation fuels, it argued it could be trusted to control liquid fuels in the public interest. It

saw the prospect of private sugar interests and the IAA state agency controlling the commercialization of ethanol as a threat to its monopoly power (Barzelay, 1986, p. 144).

Usineiros opposed giving power Petrobrás and IAA and succeeded in limiting state control over ethanol marketing. Part of their success came from their ability to leverage broader critiques about the military government's activism. Like the military governments preceding him, President Geisel faced growing pressure to keep the state out of the national economic elite's desired terrain (Saad Filho, 2010). Copersucar, the powerful São Paulo-based cooperative, viewed state-controlled marketing negatively, arguing that too much state ownership of the Brazilian economy would impinge on the ability of the national bourgeoisie to make the best economic decisions. Copersucar also worried giving the IAA or Petrobrás a monopoly as the sole ethanol purchaser would eventually lead to a state-takeover of the entire industry. The Council for Economic Development (CDE), which oversaw the development of the policy details for ProAlcool, initially believed the IAA should be given monopoly control over ethanol marketing. However, the opposition from usineiros was effective. CDE determined that there should not be a state monopoly over ethanol marketing. Instead it gave the National Petroleum Council (CNP) the responsibility of guaranteeing both a market and a price for all ethanol used for fuel and chemical end products.[116] It also provided ethanol producers the freedom to decide where to sell their product (Barzelay, 1986, p. 145). The CDE's decision to deny monopoly control over ethanol marketing was a big win for ethanol producers.

Petrobrás responded with a plan to support cassava-based ethanol production as a way to assert some control over the burgeoning ethanol sector. Petrobrás set out to realize the vision articulated by the Ministry of Agriculture, MIC, and CNPq, and other state agencies of a cassava-to-ethanol production system that transformed the Cerrado region of Brazil into an agricultural frontier. Although it made overtures to financing agricultural developments for manioc cultivation and industrial R&D for manioc processing, in the end Petrobrás focused only on building a demonstration pilot plant to prove that cassava could compete with sugarcane in the ethanol production chain (Barzelay, 1986, p. 143). Petrobrás constructed the first cassava-to-ethanol demonstration plant in 1976 in Curvelo, Minas Gerais. To operate for an entire year producing 60,000 litres per hectare, the plant would require the large-scale production of cassava. Petrobrás planned to cultivate a 2000-hectare cassava planation next to the ethanol plant, which required procuring enough cassava plantings to ensure the plant could operate at capacity for its entire first year (Correa, 1980).

However, the Petrobrás cassava-ethanol project deviated significantly from the Ministry of Agriculture's vision, which entailed a number of major technological and ecological challenges. The plant utilized an industrial process developed by the National Institute of Technology (INT). The relatively large size of the plant contrasted with the original idea for mini-distilleries that would be able to source cassava from local, small subsistence farmers. Instead, the size of the Petrobrás demonstration plant necessitated a cassava plantation. There was little technological support available to run a cassava-to-ethanol plantation. Cassava had been a popular but labor-intensive crop throughout Brazil's rural landscape. Its unique social characteristics and biodiversity made for a wide range of agronomic practices depending on the region. For instance, in the Northeast of Brazil, where 50 percent of total cassava production

[116] The CDE initially believed the IAA should have monopoly control on all ethanol.

concentrated, smallholders collected the lowest yield, whereas producers in the South (a much wealthier region) had the highest yields but the smallest concentration of growers (Lorenzi et al., 1980). Still, no one had developed mechanized industrial infrastructure to harvest cassava in a plantation setting (Correa, 1980).

Adapting cassava into a raw material for ethanol production also posed a number of problems. A major challenge was procuring plantings suitable for the first major cassava plantation in the Cerrado biome. Given its popularity as a subsistence crop, the Brazilian government had developed an interest in improving cassava cultivation to expand agricultural production in the Cerrado biome of the Midwest region of Brazil. Cassava's ability to withstand drought and poor soil conditions made it a prime candidate for cultivation in the Cerrado. The Ministry of Agriculture's Brazilian Agricultural Research Center (EMBRAPA) had established a national center for cassava research to improve cassava yields.[117] However, little R&D had yet been carried out on the cassava varieties in the Cerrado region, much less which varieties would be best suitable for large-scale production in the Cerrado. Such an endeavor would require confronting numerous agroecological problems, like low soil fertility, high aluminum levels in the soil and poor water availability (Lorenzi et al., 1980).

However, bacterial blight proved to be detrimental to Petrobrás' cassava-to-ethanol project. In order to fill the 2000-hectare cassava planation needed to feed the demonstration plant's scale of production, Petrobrás sourced cassava stakes from various locations. Transplanting cassava stakes was a delicate process (Correa, 1980). Viable stakes must have well-lignified branches of a certain diameter and healthy buds. Transportation of the stakes from their source to the plantation must be done quickly, especially in hot weather; otherwise the buds will sprout too soon and the stakes will dehydrate. In addition, saving stakes for later planning raises the risk of insect and disease attacks. Petrobras' cassava plantation comprised of diverse varieties of cassava, none of which were adapted to resist disease and pests, fell victim to cassava bacterial blight (CBB). The project motivated research into CBB. Yet, compared to efforts in the sugarcane-to-ethanol production chain in the Center South, it did not inspire public or private sector investment in the cassava-to-ethanol route as an economically viable model of production.

An ethanol imaginary dissolves

By contrast, ProAlcool inspired a surge of private investment into the already well-developed sugar-ethanol production network. Even though ProAlcool authorized an unprecedented volume of public subsidies to support the annexation of ethanol distilleries to existing mills, the release of funds was slow. The Central Bank viewed the future for ethanol with great uncertainty, reflecting a general concern about which entities would determine Brazil's ethanol future. Rather than wait for the Bank's financing bottleneck to clear, wealthy usineiros in São Paulo financed expansion projects on their own, in anticipation of government funding coming through (Barzelay, 1986: 168). This delay in financing further disadvantaged fornecedores (see previous section) who could not afford to move ahead by financing their own distillery expansion to jump started ethanol production.

[117] As a federal agricultural research organization, EMBRAPA (Empresa Brasileira de Pesquisa Agropecuária) focuses on rural extension services for smaller farmers.

These investments in sugar-ethanol spurred new breeding and cultivation methods, as well as industrial process engineering innovations such as improved sugar extraction, power co-generation using bagasse (a by-product left after the juice is extracted from sugarcane), and the application of vinasse (another by-product of distillation) as a fertilizer in sugarcane fields (Moreira and Goldemberg, 1999).[118] Such developments mobilized a vigorous expansion of Brazilian ethanol production that helped to enrich usineiros and inspire new technological developments. As a result of these dynamics, by 1978 over 80 percent of ethanol production was concentrated in São Paulo state, almost all of which was produced in annexed distilleries of COPERSUCAR (Barzelay, 1986: 167-9).[119] By the mid-1980s, the efficiency of growing sugarcane and processing ethanol had improved significantly as a result of these innovations (Goldemberg et al, 2008).

Without greater institutional support to develop cassava-ethanol production systems, the quick growth of sugar-ethanol production by annexed distilleries vitiated ProAlcool's goal of income redistribution. Even though the ProAlcool decree promoted state subsidies for cassava-ethanol production projects, CNAl considered few cassava project proposals. Technically, CNAl was directed to approve all projects that demonstrate alignment with the objectives of ProAlcool, the CNAl selected very few cassava proposals (Barzelay, 1986: 158-161). However, CNAl approved few cassava proposals, perhaps because such projects were unlikely to pass evaluation by the Central Bank (Banco do Brasil). Among the Central Bank's lending criteria was a requirement to show project profitability at a rate acceptable to the bank—something few if any cassava-plant entrepreneurs could provide.

Beyond financing, the imaginary of diversified production also required greater attention to clarifying and supporting new social relations of production between the public and private sectors. For instance, developing a cassava-ethanol production chain would require greater coordination between Petrobrás, the Ministry of Agriculture, the Ministry of Industry and Commerce, and the National Council of Technologic Research (CNPq) about how the cassava-ethanol production network should took shape and function. Material change at the landscape level would require understanding how the biophysical capabilities of the cassava plant intersect with different relations of production. For example, a publicly run and publicly owned cassava-ethanol industry subsidized by the state could have taken shape around small producers contributing to a network of mini-distilleries. Petrobrás did attempt a second project involving cassava sourced from local smallholders (Barzelay, 1986: 158-9). But by 1978, the production of sugar-ethanol had taken off, and ethanol production outstripped consumption, straining storage and distribution infrastructure.

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[118] The National Program for the Improvement of Sugar Cane ("Planalsucar"), supplied growers cost-cutting biological control systems and pest- and disease-resistant sugarcane varieties with increasingly higher sucrose content (Hall et al., 1992; Wilkinson and Sorj, 1992). In addition, the government-run Institute for Sugar and Alcohol (IAA) supervised funding to Copersucar Technology Centre (CTC), the non-profit research arm of sugarcane producers in São Paulo, which implemented a plant breeding program of similar magnitude to Planalsucar and improved industrial engineering (Wilkinson and Sorj, 1992). By the mid-1980s, the efficiency of growing sugarcane and processing ethanol had improved significantly as a result of these innovations (Goldemberg et al, 2008).

[119] By 1977, Copersucar accounted for 90 percent of sugar production and 91 percent of ethanol production in Sao Paulo.

As the imaginary of a bifurcated ethanol production network began to dissolve, uncertainty about the future of the sector increased. The state regulated the ethanol market tightly using production quotas and price controls. It provided for guaranteed purchases from Petrobras and mandated ethanol procurement by gas stations. However, in failing to see through the state's vision for cassava-ethanol producers, and by giving up monopoly power over ethanol fuel marketing, the CDE failed to clarify ethanol's future in Brazil. Because world sugar prices remained low, the CDE was able to avoid answering the question directly; it periodically agreed to increase the legal quota of sugarcane that could be directed towards ethanol production, without addressing what would happen to ProAlcool once sugar prices began to rise again. Would ethanol be a temporary measure to help sugar producers, or a longer-term energy strategy?

In the wake of the imaginary of diversified production, the political culture of economic governance shifted more decisively away from the tradition of the Estado Benefactor. Indeed, the imaginary had threatened to undermine the oligopolistic power of the Sao Paulo sugar elite, but more importantly it underscored the failure of the outorga. The military government's pursuit of a developmental strategy for income redistribution lacked strong interest group backing. Like other industrial policies in Brazil, microeconomic planning for the sector responded to the needs of the most powerful sectoral interests (Hochstetler and Montero 2012; Suzigan, 1978). As an outorga, ProAlcool exposed a deep disparity between the logic of the Estado Benefactor and its capacity to direct sociotechnical change as a means for more equitable economic growth.

As described in more detail in the next section, a change in logic of economic governance was underway. This shift had begun during the Geisel Presidency, as the National Congress took a number of steps to limit presidential powers. When Geisel assumed power, the military government was undergoing a loss of legitimacy both externally among the citizenry and within the military (Skidmore, 1988: 157-163). Military rule was premised on the promise of an eventual transfer of power from dictatorship to democratic civilian rule. However, it appeared to be losing control of the main goal of the planned transition: to distribute political capital among the societal sectors deemed fit to govern the economy (Codato, 2006; Skidmore, 1988). To avoid being overthrown before the scheduled democratic transition, Geisel tried to shed ties to the repressive national police and its torture network in order to focus on building popular support through economic growth. However, the National Congress sought greater institutional safeguards against authoritarian power in the Presidency. In 1978, Constitutional Amendment No. 11 revised the 1967 Constitution, re-establishing habeas corpus, suspending radio and television censorship, revoking capital punishment and life term prison sentences, restoring independence to the Judiciary, and denying the president the power to make laws (Codato, 2006).[120] To add to this, up until 1979, Brazil resisted international pressures to follow more restrictive monetary policy.

This shift away from the tradition of Estado Benefactor continued to unfold during the next military regime of General Figueiredo. By 1979, when President Jõao Figueiredo entered

[120] However, the Congress was not given full political immunity. As Codato (2006) explains, the President, as chief of the Executive Branch, could no longer terminate mandates and suspend political rights. Yet, members of the parliament could be tried by the dictatorship for what were deemed cases of "crimes against national security."

office (1979-1985), the problem of overproduction by sugar-ethanol producers remained, with no new vision of what the overall liquid transportation sector should look like going forward. After three years into ProAlcool's implementation, Brazil's political leadership continued to debate whether the state or market would be the main regulator of the ethanol sector. As Brazil's largest corporation, Petrobrás continued to assert its natural ability to regulate all liquid transportation fuels. It proposed the creation of a new state-owned ethanol company to operate under its control called "Alcoolbras," which would allow it to protect its monopoly (Barzelay, 1986: 182-3). Yet public confidence in Petrobrás had suffered a serious blow from the OPEC oil price hikes, which had the effect of making more pronounced its failure to develop domestic petroleum production capacities.

Private ethanol interests, multinational automobile manufacturers, and the Ministry of Industry and Commerce wanted private sector control. They proposed the creation of "Investiálcool," a private institution that would serve as a kind of development agency to lobby on behalf of producers and provide financing for new ethanol plants. The ownership of Investiálcool would follow what Peter Evans (1979) has termed the tri-pé (tripod) model of development, whereby ownership is split evenly three ways between local capital, foreign capital and the state. In addition to the state, the Investiálcool tri-pé would include the auto industry as multinational capital, and the usineiros, private local capital goods producers, and construction engineers as local capital (Barzelay, 1986: 184). Like President Geisel, President Figueiredo was vulnerable to mounting critiques about the role of the state in the economy. President Figueiredo accepted the industry proposal for Investiálcool (later renamed "Brasálcool"), thereby solidifying the state's commitment to allow the private sector to control the ethanol industry, not Petrobrás.

In the years after 1979, the ethanol industry led by the Investiálcool tri-pé, hit a sweet spot in which demand for ethanol expanded through a number of initiatives by the government and the automobile industry. The government brokered an agreement with the automobile industry to increase the minimum ethanol-gasoline fuel blends from 20 percent to 25 percent ethanol (BNDES and CGEE, 2008). Further, General Motors, Ford and Volkswagen expressed interest in producing ethanol-only cars. Although the automakers had already invested in R&D for alcohol-only cars in 1976, they were unwilling to take the next step of retooling the factories of their Brazilian subsidiaries without stronger policy supports in place (Sperling, 1988). The government responded with various mechanisms to ensure consumer adoption of ethanol cars, including mandating ethanol retail at gas stations; guaranteeing ethanol prices could compete with gasoline by capping ethanol retail prices at 65 percent of gasoline; managing ethanol reserves for supply stability; reducing the registration tax on ethanol-only cars; and opening up more credit for ethanol-only car purchases (Sperling, 1988; Barzelay, 1986). By the end of 1980, new ethanol-only car sales were booming.[121]

In addition, policies targeting ethanol producers inspired another wave of private investment in ethanol production, this time in autonomous (not annexed) distilleries. In order to ensure that ethanol production expanded to meet the growing demand for ethanol in the domestic consumer market, the government set guaranteed prices for ethanol producers and opening up new credit lines for sugar mills to further expand their capacity (Sperling, 1988; Barzelay, 1986).

[121] Within a year, total ethanol-only car sales increased from 1% in January 1980 to 73% by December of that year (Sperling, 1988).

Private investment for the construction of dedicated ethanol distilleries grew, de-coupling ethanol production processes from sugar production processes. These new mills soon accounted for half of all ethanol output (Demetrius, 1990). The growth of autonomous distilleries did not trigger significant growth in land use dedicated to sugarcane cultivation, highlighting Copersucar's strength in enhancing productivity through innovation in sugarcane breeding and ethanol process-engineering.

5.3 Sweetening Brazilian cars and carbon

Two decades after the first imaginary of diversified production, a new ethanol imaginary emerged during the Cardoso Administration (1995-2002). After a decade of stagnation, the Cardoso government re-imagined the ethanol industry as part of a larger strategy to achieve greater political autonomy in the international system and economic strength in Brazil's now "open" economy. As Brazil existed the economic turmoil of the 1980s and 1990s and ushered in a new era of neoliberal institution building, the Cardoso focused intently on upgrading the country's capacity for technological innovation and establishing Brazil in an international system in which Western governments, especially the United States, increasingly exercised political and economic influence over governments in the developing world under pressure to accept the prescriptions of multilateral international financial institutions, backed by major industrial nations. Although democratization and neoliberal reforms had weakened the planning capacities of the military-developmentalist state, under Cardoso, state actors focused intently on developing long-term planning capacities through science and technology (S&T) policy, for example by establishing new bodies like the Center for Strategic Management and Studies (CGEE) as a strategic planner. It also enrolled the state's foreign policy and development banking capacities to carry out long-term planning strategies focused on building an internationally competitive innovation system that would be the new wellspring of Brazil's future economic growth. In doing so, Cardoso's administration articulated a new tradition of state participation in Brazil's more open economy.

Below, I refer to this tradition as "open-economy industrial policy," building from the scholarship of Shrank and Kurtz (2005) and others. After a short historical overview of major political and economic changes during the 1980s and 1990s, I describe a shift in Brazil's political culture of economic governance away from the tradition of the Estado Benefactor to a new tradition of "open-economy industrial policy." I then examine the ethanol industry more closely in this context. I argue that a new imaginary of ethanol emerged during this time in the mold of this tradition of economic governance. This imaginary aimed to sweeten the image of ethanol in consumer markets through supply-side incentives.

Brazil changed dramatically in the 1980s, as the country underwent a transition to democracy and a period of abertura ("opening" of the economy to foreign investment and adherence to international rules). A new civilian-led military regime self-titled the "New Republic" would realize the long-promised transition to a fully-democratic regime. In 1985, José Sarney took office as the first civilian president in twenty-one years in what would be the last

military regime.[122] The Sarney government faced numerous challenges from political pressures from above to liberalize the economy as well as pressures from below to develop institutions for democratic negotiation (Skidmore, 1988, p. 210-213). Many of the industrial and political elite advocated strongly for greater privatization of state industries and trade liberalization in order to let market forces play a stronger role in Brazilian economic development (Amann and Baer, 2005). At the same time, the state was under immense pressure from labor unions and the political left to establish protective labor laws and pursue agrarian reform (Skidmore, 1988, p. 283-303)—reforms that hinged on need to write a constitution to complete Brazil's transition to a democratic regime (Skidmore, 1988, p. 306). The Sarney government's decade lone tenure was largely preoccupied with a recovering from a credit crisis, managing foreign debt, and negotiating foreign investment—all of which firmly stripped the military regime of its prestige as the progenitor of the "Brazilian miracle."[123] Despite its struggles to formulate an economic plan, by the end of the decade, the Sarney administration had overseen the last iteration of the transition: establishing the political hegemony of the military regime's opposition party in 1986,[124] promulgating a new Constitution in 1988, and carrying out popular presidential elections in 1989 (Codato, 2006).

Under the next three democratic administrations, the Brazilian state underwent a number of changes towards becoming a neoliberal regulatory state. The Collor de Mello administration (1990-1992), the Itamar Franco administration (1992-1995), and Fernando Henrique Cardoso' s presidency (1995-2002) oversaw a period of "democratic consolidation" in which Brazil formed a Federalist system modeled after the US (Codato, 2006). These administrations all pursued market-liberal policy goals inherited from the Washington Consensus as a strategy for accelerating economic recovery from the credit crisis (World Bank 1994, 25-30). Over the course of the 1990s, neoliberal economic policies triumphed throughout Latin America as the old ISI policies became generally accepted as an inefficient development strategy for economies in desperate need of capital inflows after the debt crises of the 1980s. Although Collor initiated the process of privatization in the steel and petrochemical industries, it was not until President Cardoso arrived in 1995 that the processes of liberalization and privatization accelerated and spread throughout the economy (Codato, 2006). During this time, a constitutional amendment passed to eliminate the legal differentiation between domestic firms and foreign firms, which allowed foreign capital to enter previously "closed" sectors such as oil exploration and public utilities (Amann and Baer, 2002).

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[122] Tancredo de Almeida Neves was the first democratically elected president (by indirect electoral college vote) after the military regime, but died the night before his inauguration. As his running mate on the opposition ticket, José Sarney assumed office upon his death.

[123] Brazil maintained high growth over the late 1970s and early 1980s through a strategy of running up a staggering foreign debt in which the country was taking out loans to pay interest on previous loans. The Sarney administration's lending halt of 1982 plunged Brazil into a credit crisis, which has arguably continued since and focused the administration's policymaking on repaying the bill for the military government. This was perhaps the worse of previous credit crises. Rapid export growth of manufactures (as opposed to commodities like coffee) helped to lift Brazil out of its 1982-83 recession. However, crisis hit again in 1987, when the Sarney government suspended interest payments to commercial bank debt in order to stop the hemorrhaging of Brazil's foreign exchange reserves.

[124] The "Partido do Movimento Democrático Brasileiro" (PMDB), or Party of the Brazilian Democratic Movement, won the general elections of November 1986. PMDB's 1982 manifesto targeted agrarian reform. Throughout the 1980s, it maintained an image as the party that fights the military government by sinking its roots at the local level.

Despite these immense structural changes, Brazil's political leaders were skeptical of mainstream economic thinking that came with neoliberal ideology. The neoliberal paradigm deemed the state's previous practices of imposing strategies on firms, selecting public investment priorities, and directing public spending using subsidies or regulatory incentives to be market-distorting (Arbix and Martin, 2010). However, the Cardoso Administration endeavored to attune the country's more "open, decentralized and competitive" economic environment to a new tradition of state participation in long-term planning activities and market coordination (Arbix and Martin, 2010; Hochstetler and Montero, 2012; Hochstetler and Montero, 2013; Ban, 2012). Their overall goal was to create an enabling environment in which domestic industries could advance in global markets (Amann and Baer, 2005; Arbix and Martin, 2010).

A new tradition of economic governance began to take shape around the introduction of long term planning capabilities that utilized Brazil's newly decentralized governance institutions in a more concerted, less clientelistic, fashion, to pursue nationalistic growth strategies. Latin American scholars have described these capabilities in terms of "open-economy industrial policy" (Schrank and Kurtz, 2005) and "market-correcting supply side policy initiatives" (Kurtz and Brooks, 2008). Generally, these policy strategies entail using the public provision of technical skills, finance, information, and infrastructure to correct market failures, in contrast to policies used during the ISI era, whereby the state sought to protect domestic industries from competition by limiting the supply of foreign goods in domestic markets. Such policies may take the form of fiscal incentives like credit subsidies for domestic firms to invest in technological innovation and pursue high-value-added market segments (Kurtz and Brooks, 2008). They may also come in the form of new infrastructure and the provision of services, for example financial services.[125]

By the start second term in 1999, the Cardoso Presidency was focused on synchronizing state investments, science and technology policy, education policy, and foreign policy to promote social and economic development jointly (Weyland, 1998). Upgrading the country's capacity for technological innovation was especially important (Cardoso, 1999). Up until this point, federal investments in Brazilian science and technology had stagnated, and public innovation systems had been partially destroyed by structural adjustment in the 1990s (Ban, 2012). Even though private investments in R&D increased greatly (Pinheiro-Machado and de Oliveira, 2001), few industries had the human and technological resources and R&D capacity to become competitive internationally (Suzigan, 1991).[126]

Cardoso also revived state financing institutions to improve investment opportunities in strategic sectors and help upgrade the country's capacity for technological innovation. A consensus within the administration developed around the importance of subsidizing companies' innovation efforts in order to better competes in international markets (Kasahara and Botelho, 2016). The National Development Bank (BNDES) and the Brazilian Research and Projects Financier (FINEP)—two bodies left over from the military government—began to focus on improving investment opportunities for private actors in strategic sectors (Hochstettler and

[125] This has had the added, and intentional, benefit of creating public employment as a stable labor market in an otherwise volatile region (Rodik, 2007).
[126] To address this, the government invested more heavily in the Brazilian educational system to ensure the growth of a labor force for high-tech industries.

Montero, 2012; Hochstettler and Montero, 2013; Ban, 2012). In addition, a number of regulatory agencies issued sectoral funds for domestic industries' R&D activities of domestic industries, which were financed by the collection of various fees and fines from the private sector (Kasahara and Botelho, 2016).

This new tradition of open-economy industrial policy elevated scientists to a more prominent position in long-term planning than leaders from the business sector. As a result, members of Brazil's scientific community became key participants in policy discussions about strategic public investment in science and technology (Kasahara and Botelho, 2016). The administration created the Center for Strategic Management and Studies (CGEE) to function as a source of expertise in science and technology (Weyland, 1998). The CGEE remains a strategic arm of the Federal government that carries out "foresight" research to identify sectoral priorities and synchronize federal science and technology policy with said priorities.[127]

In addition to synchronizing S&T policy and public sector finance, the tradition of open-economy industrial policy entailed a new approach to foreign policy. The Cardoso Administration had maintained a long-standing approach of "autonomy-through-participation:" a strategy of asserting political autonomy by defending national sovereignty and national interests combined with engaging in foreign policy to influence the rules of global economy to be more favorably for Brazilian industry (Vigevani and de Oliveira, 2007).[128] Cardoso had backed the decision to sign the Final Act of Marrakesh, which created the WTO in 1994, when he served in the Ministry of Finance under President Franco. However, during the US government under George W. Bush, Cardoso sought to counterbalance the threat of US unilateralism on Brazil by developing stronger relations with China, India, and South Africa while simultaneously seeking greater dialogue with the US. As Vigevani and Oliveira (2007) argue this represented a shift from "autonomy through participation" to "autonomy through diversification" in which Cardoso sought to "form regional alliances with non-traditional partners (China, Asia-Pacific, Africa, Eastern Europe, Middle East, etc.), trying to reduce asymmetries in external relations with powerful countries" (p. 1313).

During this time, a new imaginary of ethanol began to take shape in the Cardoso government. Structural adjustment brought an end to price controls, export taxes, and production quotas for both the sugar and ethanol industries. The administration also ended the subsidy for hydrous ethanol. However, the total deregulation of the ethanol sector did not signal a lack of interest on the part of the Cardoso Administration. With oil prices beginning to climb, political favor for ethanol began to return. The government began to examine new strategies for supporting the ethanol sector as a strategic industry using tools from the tradition of open-economy industrial policy.

A key question for the administration was how to bring back ethanol demand. From the mid-1980s through 1997, ethanol production experienced a decade of stagnation. The debt and credit crises of the late 1980s and early 1990s meant decreasing investments for the ethanol industry (Rosillo-Calle and Cortez, 1998). However, alcohol consumption remained high because over 80 percent of the Brazilian passenger car fleet ran on ethanol fuel. In the absence of

[127] See UNIDO report, Santos & Filho
[128] Vigevani and Oliveira (2007) trace this strategy back to the Rio Branco Administration (1902-1912).

economic incentives and direct government controls, the ethanol industry—like many sectors of the Brazilian economy—became vulnerable to a combination of market forces that triggered a downward trend in ethanol consumption. The rapid increase in ethanol-fueled passenger cars introduced a number of coordination problems. The growth in production of ethanol for ethanol-only cars created costly gasoline surpluses for Petrobrás, which had to be exported and trigger a political backlash against ethanol within the state (Rosillo-Calle and Cortez, 1998). This coincided with a tapering-off of ethanol production when the world price of sugar began to increase in the late 1980s. Without higher prices paid for ethanol, sugarcane growers chose to produce for the sugar market over the ethanol market. To add to this, world petroleum prices dropped and domestic oil production increased (Rosillo-Calle and Cortez, 1998). The government set the guaranteed purchase prices of ethanol below production costs, further eliminating incentives for usineiros to make ethanol over sugar. In this context, a severe shortage of ethanol led to an increase in cheap imports of ethanol and methanol from the US. By 1989, only 51% of new passenger cars were ethanol powered, down from 85 percent in 1985[129] Moreover, as discussed in the previous section, political uncertainty had emerged around the future of the ProAlcool program. The ethanol industry in Brazil suffered a major loss of credibility among consumers during this time as the world's largest importer of ethanol from 1989 to 1996 (Kojima and Johnson, 2005).

To reignite ethanol consumption, a new vision for ethanol expansion began to take shape focused on "sweetening" Brazilian cars and global carbon. In the late 1990s the Cardoso government devised an innovation strategy to revive domestic demand for ethanol. Consumer memories of ethanol fuel shortages continued to undermine ethanol-only car sales throughout the 1990s. Despite an initial lack of interest, the government incentivized Brazilian engineers to develop flex-fuel engine technology (de Carvalho, 2013). With more cost-effective fuel sensors, Brazilian flex fuel vehicles (FFV) could enable consumers to fuel their cars with pure gasoline, pure ethanol or blend of the two. In 1999, Brazilian-based engineers began working to adapt flex-fuel engine technology (already available in the United States) for the Brazilian automobile industry (Nascimento et al., 2009). By 2001, the technology was ready for commercialization and perceptions of ethanol were improving. The Cardoso government brokered a deal with automobile manufacturers to begin flex-fuel vehicle (FFV) production in 2003. To ensure a domestic market for FFVs, it promised to offer the same tax breaks as alcohol-based vehicles beginning in 2002 (Kojima and Johnson, 2005). Brazilian sugar producers had begun to increase their ethanol output in 1999 amid increasing oil prices and ramped up production to meet the demand for ethanol created by FFV sales (Goldemberg, 2004).

With domestic consumption of ethanol fuel and FFVs rebounding, the Cardoso government launched a biofuels diplomacy initiative to extend the industry's reach internationally. After exploring the potential for other domestic niche markets for ethanol (e.g. for blending with diesel fuel, producing fuel cells) (Chum, 2002), Cardoso's Ministry of Science and Technology (MCT) proposed that developed countries' interest in limiting CO2 emissions could help create a future international market for ethanol. In conjunction with the Brazilian Sugarcane Industry/UNICA (União da Indústria de Cana-de-Açúcar), the largest lobbying

[129] In 1985, over 85 percent of all new cars sold were ethanol-only cars and approximately one fifth of the Brazilian passenger car fleet was running on ethanol-only (Sperling, 1988). See also, ESMAP (2005): "Potential for Biofuels for Transport in Developing Countries

organization for sugarcane and ethanol producers, Brazilian diplomats and energy experts, joined by development experts from the United Nations and European countries, advocated "a vision of energy as an instrument of global and national development and of technology as a crucial mechanism for making this possible" (Moreira and Goldemberg 1999; Goldemberg et al., 2004; Goldemberg et al, 2008). Their vision framed Brazilian ethanol both as a drop-in solution for governments considering low-carbon alternative fuel consumption to mitigate climate change, and as a turnkey industry for poorer countries seeking rural economic development. Biofuels diplomacy fit well within the Cardoso government's existing diplomatic missions to explain how Brazil would be changing in the near future, from a developing country into a fast growing newly industrialized country that was ready to receive international investment.

To support biofuels diplomacy, Brazilian academic and government officials reframed the Brazilian ethanol experience in the emerging regulatory language of global carbon cycles. New scientific publications help to recount Brazil's history with ethanol in terms of the greenhouse gas emissions avoided from displaced fossil fuel consumption and sequestered carbon in agricultural sinks (See Moreira and Goldemberg 1999) Foreign policy representatives helped reinforce this narrative in international policy arenas by reinforcing the general equation of increased ethanol consumption as decreased CO2.

For its part, UNICA provided reassurance that the sugar-ethanol industry could meet projections for international ethanol demand sustainably should such a global market come into being. To appease concerns that intensified ethanol production would cause negative ecological impacts, UNICA and BNDES emphasized the industry's ability to increase its sugar and ethanol productive capacity without increasing its current use of inputs and without causing significant land use changes to the agricultural landscape (BNDES, 2008). At the center of this claim lay the industry's the sugarcane improvement innovation network established under ProAlcool and Planalsucar. UNICA promised that their accomplishments in traditional plant breeding and plant biotechnology would provide for increases sugarcane yields and sucrose content, thereby allowing the industry to expand sugar production without significant land use requirements. In addition, changes to cultivation and processing methods would further improve ethanol's impact on lifecycle CO2 emissions. Traditionally, the industry incinerated the sugarcane crop prior to harvest. UNICA launched a new initiative to end this practice through the introduction of mechanized harvesting. The otherwise burned crop residues (the tops and leaves of the sugarcane) would then become energy inputs, as was already the case for bagasse (Moreira and Goldemberg 1999).

The ethanol imaginary of sweetening Brazilian cars and foreign carbon emissions proposed a nation-building strategy that avoided limiting Brazil to the role of supplier of a low-value commodity. Growing the ethanol industry by incentivizing new technologies would contribute to the overall national strategy of using open-economy industrial policy to advance Brazil into a new role as a technology supplier. The Lula Administration built upon this imaginary by advocating Brazil's ability to be the leading global exporter of ethanol technologies, not only for FFVs but also for turnkey ethanol plants and sugarcane varieties. As discussed in the next section, the Lula government tweaked this imaginary further in its efforts to position Brazil as a leader of 'South-South' alliances and a stronger player among the governments of the Global North.

5.4 Competitive Cellulosics from the Cerrado

With domestic ethanol consumption stabilized by FFV sales and biofuels diplomacy well underway, the Lula Administration (2003-2010) built upon the Cardoso imaginary of sweetening cars and carbon. President Lula forged strategic partnerships with governments in North America, South America, Europe and Africa to secure international markets for Brazilian ethanol (Burges, 2005; European Parliament, 2007; Vigevani and Cepaluni, 2007).[130] The new administration also focused more intently on leveraging ethanol expansion as a climate-mitigation technology that created new opportunities for rural development in the global South. Essentially, Lula extended this imaginary from Cardoso's downstream focus on expanding ethanol consumption to include an upstream focus on expanding ethanol production systems. In doing so, he also the Cardoso government's tradition of open-economy industrial policy by applying the tool of supply-side interventions to expand the value of Brazil's ethanol production model. Ethanol technology transfer opportunities between Brazil and other countries were multifold, thereby positioning Brazilian industries as a supplier of high-value manufacturing technology. Brazil's agricultural research agency EMBRAPA also proposed to help implement sugar-cane plantations in developing countries with tropical climates. Brazilian firms, like the giant construction and engineering conglomerate, Odebrecht, were positioned to lead joint ventures to build ethanol plants abroad. Extending this imaginary also built upon the foreign policy strategy of the Cardoso government in which Brazil positioned itself to lead South-South alliances in the arena of international trade politics.

The Lula Administration also developed a new imaginary that reincorporated key elements of first imaginary discussed above, the imaginary of diversified production. In this imaginary, the state once against proposes Brazil's Cerrado biome as the next agricultural frontier for low-carbon, sustainable ethanol production. It also invokes the tradition of the Estado Benefactor by repositioning the government in a paternalistic role, whereby the state assembles an outorga. However, elements from the military government's use of the tri-pé organizational form are also evident in this imaginary. More specifically, the state is positioned to provide the main organizational initiative for what I describe as an effort to establish an informal tri-pé comprised of the President, the Ministry of Science and Technology, and BNDES acting on behalf of the state; UNICA, and; international capital. Below, I argue that despite the capabilities of the tri-pé, which have been demonstrated in other sectors,[131] the imaginary of competitive cellulosics in the Cerrado faces inherent barriers as an outorga. In other words, the state's paternalistic belief in its own ability to manage diverse national interests based on its state-centered preemptive vision of who may benefit from the imaginary it proposes.

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130 Two examples of this are the European Commission-Brazil Energy Policy Dialogue and the 2007 US-Brazil Memorandum of Understanding (MOU) to Advance Cooperation on Biofuels.

131 "Tri-pé" is the term proposed by Peter Evans (1979) to describe a public-private model of company ownership that contrasts with state-owned enterprises, whereby one-third of the company is owned by local capital, one-third by foreign capital, and one-third by the state. As Evans (1979, 1995) describes, the tri-pe model has been applied in Brazil's petrochemical, computer industries, and electronic industries, most famously under General Geisel. The tri-pe was first proposed under a special working group involving the military and nationalist technocrats who settled on a model in which the state would take the organizational initiative in creating a new ownership structure split equally among a state-owned enterprise, a local private firm, and a foreign company (Evans, 1995: 118-136)

By the end of Lula's first term, a number of countries had established government mandates to increase low-carbon fuel consumption by blending ethanol with gasoline. Worldwide demand was set to grow. Domestic consumption of ethanol fuel and FFVs also continued to rebound under favorable tax policy, allowing the government to focus more intently on extending the industry's reach internationally (see Goldemberg et al, 2008; Zuurbier and Vooren, 2008). Brazilian ethanol producer groups asserted their ability to double their production output. To support this claim, Brazilian "biofuel diplomacy" intensified. The Lula government sponsored international conferences on biofuels and funded scientifically based studies and public relations campaigns demonstrating the veracity of the industry's future output projections (see BNDES, 2008).

However, the "nature" of sugarcane ethanol posed a number of challenges to this expansionist vision. For one, a global civil society backlash to biofuels was well underway by 2006, putting pressure on governments in ethanol-importing countries to create verification systems for the sustainability impacts of ethanol imports. Critical attention focused on whether Brazil's ethanol sector would lead to more Amazon deforestation. Many industry arguments rested on the use of new biotechnologies that would enable higher yields, which in turn would reduce pressure on land use change. However, higher-yielding technologies raised additional concerns about water use, water contamination from agricultural inputs, and genetically-modified organisms (GMO). A potentially more threatening concern emerged questioning ethanol as a carbon mitigation technology: whether ethanol production produced more or less GHG emissions over the product lifecycle compared to gasoline. Here, Brazil had a competitive edge on US producers, due to its use of bagasse as a source of energy in ethanol distillation, and also assuming its producers mechanized their sugar plantations to remove the need to burn sugarcane. However, this plan raised a social impact problem for UNICA: mechanization would reduce the manual labor needed for cutting sugarcane.[132] Concerns also emerged about how the increased consumption of US-produced ethanol may impact world grain prices (by diverting corn away from feed markets to fuel markets) indirectly causing land-use change in Brazil, as farmers may find the higher grain prices a good incentive to deforest Amazon land for soy production. Although this did not inherently implicate São Paulo's usineiros, it undermined their efforts to market ethanol as an Amazon-friendly commodity.

Disagreements emerged over how ethanol expansion should take place. Ethanol producers called on the National Development Bank (BNDES) to fund new plant constructions for first-generation production systems in underutilized "degraded lands" in the Cerrado region. Expanding first-generation sugarcane-ethanol systems without encroaching on globally mythologized Amazon rainforest would improve upon the avoided GHG emissions claimed by

[132] Although ethanol expansion promised to increase manufacturing jobs by 20,000, mechanization would likely cut the number of sugarcane agroindustry employees by almost half, from 260,000 manual cutters to 146,000. Mechanization also aims to solve other laborer welfare problems such as air pollution impacts. However, with the disappearance of sugarcane harvesting jobs, rural laborers face future unemployment. A number of mills are working in partnership with the Federation of Rural Worker of the State of São Paulo (Feraesp) with sponsorship from agricultural technology firms including Syngenta, John Deere and the Case Group and the Inter-American Development Bank (IADB) to lead an initiative to retrain up to 7 thousand workers per year for new occupations. In the meantime, workplace exposures continue and reports of human rights abuse and worker exploitation remain common in the sugarcane industry.

sugarcane-ethanol producers. Already, first-generation systems projected greater reductions in GHG emissions due to plant breeding, biotechnology innovations, and the base of innovations achieved by Planalsucar and Copersucar. Mechanized harvesting promised to further increase sugarcane yields. These productivity gains would alleviate pressures on land use change. Even so, São Paulo's ethanol producers pushed for state support in developing the Cerrado as the next agricultural frontier for first generation sugarcane-to-ethanol production systems, as it was not clear these entities could successfully lead the ethanol industry through more radical technological change (Furtado et al., 2011; Kaup, 2015; Granco et al., 2017). Thus, Cerrado expansion remained a central part of the industry's strategy for supplying more ethanol to Brazil and the world.

Various state actors viewed further investments to expand first-generation sugar-ethanol production systems at the expense of developing second-generation cellulosic-ethanol production would set Brazil's industry behind the US. These actors viewed investments in cellulosic innovation in US and European research institutions and firms as a threat to the vision of Brazil as the leading purveyor of ethanol technologies in international markets (João et al., 2012). For the state, not pursuing cellulosic ethanol would be a missed opportunity in many regards. Cellulosic production could help assuage growing concerns about the environmental impacts associated with Brazilian ethanol production if cellulosic routes led to greater productivity on less land. With the push for sustainability certification to distinguish "good" biofuels from "bad" biofuels (Van Dam et al., 2008), more efficient cellulosic routes could improve the industry's performance against international sustainability criteria (Regalado, 2010). In addition, government investment in cellulosic S&T could help strengthen the Brazilian innovation system in the growing presence of multinationals (Wilkinson and Herrera, 2010).[133]

Despite arguments from São Paulo industrialists and policy actors that they could remain competitive internationally without the expense of cellulosic R&D (Regalado, 2010; Goldemberg, 2009), the Ministry of Science and Technology (MS&T) launched a cellulosic initiative. Following recommendations made in 2005 by the Center for Strategic Management and Studies (CGEE), the Ministry of S&T built the Center for Bioethanol Technology ("Centro de Tecnologia de Bioetanol" (CTBE)/Bioethanol Technology Center) in 2009 (CGEE, 2009). The CTBE has been dedicated to understanding how cellulosic innovation can address issues of capacity expansion, international competition, and sustainability. Researchers and staff at the CTBE work with public and private stakeholders to steer cellulosic ethanol development in Brazil.

In its first two years, before construction had completed, the CTBE hosted workshops on a range of topics selected by the lab, from no-till farming and mechanization, to biodiversity conservation and sustainability certification, to technological advances in cellulosic conversion. With participation open to interested stakeholders, the CTBE endeavored to create a "socially-robust" agenda for cellulosic innovation. This agenda would be "oriented by society" (as opposed to the typical 'pipeline model' where science is conducted for industry or government

[133] In 2008, the Ministry of Science and Technology lamented Monsanto's acquisition of two leading Brazilian biotechnology firms, whose extensive sugarcane breeding expertise was rooted in the old Planalsucar program. There is some indication that the Brazil-US MOU fostered Monsanto's acquisition of Allelyx and Canavialis, as expressed by a panelist in the US Department of Energy's Sustainability Platform Review Panel in 2011.

clients) and carried out through local and international research partnerships at the CTBE's pilot plant and virtual biorefinery (Buckeridge, 2009a, 2009b; Buckeridge, et al., 2012).

The CTBE's national vision for future cellulosic production projects new varieties of sugarcane grown in a "forest-sugarcane system" in the Cerrado region that feeds both first-generation and cellulosic systems (Buckeridge et al., 2012). Second-generation cellulosic-ethanol as well as first-generation sugarcane-ethanol production projects will utilize new varieties of sugarcane and woody biomass grown in combined "forest-sugarcane system" in the Cerrado region. Responding to international concerns about the sustainability of Brazilian ethanol production, this vision proposed that improved protections under Brazil's Forest Code would ensure ongoing intensification in the cattle industry (meaning no more deforestation, and instead using existing or marginal land to raise cattle in a feedlot system) (Brannstrom et al., 2012). Thus, a new sugarcane landscape will not push ranchers further into the Amazon. In the CTBE's national sociotechnical imaginary of cellulosic ethanol production, Brazil's Forest Code provides the key mechanism for guaranteeing no new deforestation and ensuring a new ethanol production landscape in under-utilized "degraded lands" in the Cerrado (Brannstrom et al., 2012).

This imaginary portrays the sugarcane-forest agricultural systems planted in the Cerrado's under-utilized "degraded lands" as a strategy for protecting biological diversity. Beginning in the 1990s, scientists and conservationists began to express concern for the Cerrado as a global biodiversity hotspot under threat from deforestation by logging, agriculture, and cattle operations. The Cerrado's isolation has served to protect the high level of species diversity and endemism that make the region the biologically richest savanna in the world and a valuable ecosystem for preservation and research (Sawyer, 2008). Compared the existing sugarcane plantations, the proposed forest-sugar system will entail intercropping forest patches (native or cultivated) into the productive landscape. This has the added financial benefit for enabling producers to gain payments for ecosystem services. Furthermore, the ecological value of these systems is expected to increase with climate change, because sugarcane is one of the few crops whose productivity improves in elevated levels of atmospheric CO2, which in turn will mean greater amounts of carbon sequestration.

This claim reinforces a territorial strategy of the state that has aimed to map and organize the Cerrado into one of two categories: threatened land that must be protected ("conservation units") or economically valuable land ("sustainable use units").[134] Whereas the former provides the political justification for creating protected land, such as national or regional parks (e.g. Araguaia National Park), the latter category focuses on developing eco-tourism and other biodiversity-based businesses like the oft-cited Brazilian cosmetic company Natura and more recently carbon offset programs. Of these two strategies, the total size of Cerrado areas protected by conservation units has been relatively stagnant. By contrast, the size of sustainable use units has grown continuously since the 1980s. These units are generally smaller in size compared to conservation units but beginning in the mid-2000s their combined area surpassed that of conservation units. However, both strategies have had limited success in contributing to the original goal laid out by the National Biological Diversity Policy (2002, Decree 4,399), which

[134] The methods of this territorial project are rooted in survey projects that began in the late 1990s to classify the priority areas for the conservation of the Cerrado and identify native floral cover -- as part of a larger science-policy discourse of agribusiness threats to remaining land and water resources.

calls for a reduced deforestation rate of 50 percent in the Cerrado biome. The imaginary of competitive cellulosics in the Cerrado proposes to provide a sustainable use strategy for Cerrado conservation.

As an outorga, the imaginary of competitive cellulosics from the Cerrado aims to reassure various publics that ethanol expansion would unfold ethically with no impact to the Amazon biome or the Cerrado as a site rich with biodiversity. By coordinating cellulosic innovation within the ethanol sector, Brazil will be able to transform the Cerrado into plantations of mixed sugarcane and forest patches that will serve to (1) increase its feedstock supplies for traditional and cellulosic ethanol, (2) increase the ecological and economic value of the Cerrado through sugar-forest plantations that promise to enhance the Cerrado's native biodiversity while sequester more atmospheric carbon into Cerrado soils, and; (3) drive innovation in Brazilian chemical and biotechnology industries. CTBE endeavors to play a central role in developing and channeling the new technologies needed to realize sugar-forest plantations. In doing so, the CTBE will exercise the state's tradition of Estado Benefactor by facilitating and steering domestic and international R&D partnerships that aim to develop synthetic biology applications for commercializing new breeds of sugarcane with thicker cell walls, higher sucrose content, and greater cellulosic mass in the bagasse, thereby providing more biomass per unit land for traditional and cellulosic ethanol production.

As part of the state apparatus, the lab can help steer commercialization through supportive government institutions such as the Brazilian Development Bank (BNDES) and the Brazilian Research and Projects Financier (FINEP)—two bodies left over from the military government that announced. Their "Joint Plan for Supporting Industrial Technological Innovation in the Sugar-based Energy and Chemical Sectors" (PAISS) released in 2011 could be one channel for targeting resources to the private sector according to the vision CTBE proffers. In addition, recent legislation amending the Forest Code to improve protection of the Amazon biome could facilitate the growth of sugarcane-forest landscapes Cerrado.[135]

This vision of ethanol began to take hold during the Rousseff Administration (2011—2016). A number of scientific research bodies within Brazil's public R&D network began to absorb the imaginary of competitive cellulosics into their own work (João et al., 2012).[136] However, recent political events including the impeachment of Rousseff and subsequent uncertainty about who will assume Brazil's presidential leadership have suspended this imaginary.

Whereas Brazil's first ethanol imaginary in 1970s proposed a diversified ethanol supply chain to included Cerrado-grown manioc feedstocks as a rural development project, the new imaginary involves a productive Cerrado as a global environmental project. By growing a mix of sugarcane and forest patches on Cerrado plantations, Brazil will not only increase its feedstock

[135] For example, the new Forest Code opens the possibility for farmers who do not want to disrupt their production to acquire legal preserves outside of their properties on an exchange, which would provide revenue to other landowners who maintain forest cover.

[136] The BIOEN Program run by the São Paulo state foundation FAPESP, as well as the government agricultural research organization EMBRAPA and the sugarcane breeding network RIDESA, all of which have now launched cellulosic R&D programs of their own

supplies for cellulosic ethanol, but will also increase the ecological value of the Cerrado. Cellulosic ethanol plantations promise to increase the Cerrado's biodiversity value and sequester more atmospheric carbon into Cerrado soils. Moreover, cellulosic technology is imagined to benefit other sectors, namely Brazilian chemical and biotechnology industries. Contained within this imaginary is the assumption that the Brazilian Estado Benefactor is equipped to lead the sector through radical technological change. In addition to the CTBE, the state under Dilma has revised Brazil's Forest Code to facilitate the deployment of cellulosic production systems. It has also begun implementing a public financing plan to channel resources to private sector actors capable of scaling up CTBE innovations. This plan positions the Brazilian Development Bank (BNDES) in an influential position over the sector, where it has authority to channel resources in direct support of the CTBE's sugar-forest cellulosic ethanol vision.

Chapter 6 The legacy of global forest governance on global biofuels governance

This chapter aims to establish the backdrop against which global biofuels governance has taken shape. I situate standard-setting initiatives for biofuels sustainability within larger trends in global environmental governance (GEG) and, more specifically, within the legacy of global forest governance. It is against this broader background that I foreground the emergence of a regime complex for biofuels in Chapter 7. Early initiatives to develop a transnational governance system for the biofuels industry explicitly looked to the forest governance experience. However, biofuels governance has developed differently from forest governance. To understand why and how, this chapter aims to map out influential relationships, structures, and processes emerging from the various regimes that have played a central role in global forestry governance.

A short discussion of definitions of governance and regimes are in order before describing the flow of this chapter. The term governance refers to a variety of strategies for implementing and enforcing collectively binding rules or providing collective goods (Börzel and Risse, 2010). The resulting arrangements constitute regimes. Building from Cutler (2002), I define a regime to be the structures and processes that give form to transnational rule-based cooperation.[137] Regimes can also be referred to as institutions, or amalgamations of multiple institutions, depending on the context. But, as an analytical unit, the term regime goes beyond that of institution by highlighting how a particular combinations of structure and process, and the corresponding involvement of various actors, forms of authority and accountability systems, achieves cooperation—the ultimate goal in global governance.[138] As Keohane (1984: 51-63) asserts, cooperation is observed when one government realizes that their own objectives have been facilitated by the policies of another government. Regimes aim to coordinate the decision-making of a certain group of actors.[139] As discussed below, the regimes involved in forest governance extend beyond government, enlarging the focus of cooperation to include how public and private sources of authority interact and conform with each another through a process of negotiation.

Interactions between public and private forms of authority continue to evolve. As Djelic and Sahlin-Andersson (2008) emphasize, the genesis, stabilization and change of overlapping public and private regimes is an ongoing process that helps re-order the world. It can be difficult to disentangle these overlaps and intersections public and private regimes. Studying the case of forest governance in greater depth provides an opportunity to clarify these entanglements. Although governance over forests has unique historical and structural differences compared to other sectors—like biofuels—the evolution of public and private regimes that have emerged over time in the forest sector have shaped the genesis of governance for biofuels and other sectors.

[137] This definition uses the term regime more broadly than the traditional definition offered by Keohane (1984), which refers to principles, norms, rules and decision-making procedures.
[138] For instance a regime may confer certain actors power by giving them a seat at the decision-making table or by defining the procedural arrangements and kinds of authority allowed for rule-making (Börzel and Risse, 2010).
[139] In the words of Charles Lindblom (1965, p. 227), "a set of decisions is coordinated if adjustments have been made in them, such that the adverse consequences of any one decision for other decisions are to a degree and in some frequency avoided, reduced, or counterbalanced or overweighed."

In the sections that follow, I first review major trends in GEG. The fields of global environmental politics and international relations describe three major trends since the early 1990s: (1) an increase in agency beyond the state; (2) a turn away from legally-binding treaties towards the proliferation of multiple regimes involving both public and private (market-based) forms of authority, and; (3) the rise of regime complexes with experimentalist governance architectures. I devote the remainder of this chapter to examining how these trends apply to transnational forest governance.

Section 6.2 discusses the limits of multilateralism in global forest governance. The 1992 Earth Summit in Rio de Janeiro inspired a number of new strategies to address deforestation and sustainable forest management. Following failed negotiations for a comprehensive multilateral regime on forest governance, many states pursued unilateral solutions. Yet, in the post-GATT political climate, WTO rules have limited the permissibility of unilateral rulemaking. Both the difficulties of multilateral negotiations and the constraints on unilateral action inspired the proliferation of overlapping sets of private regimes seeking to establish transnational forest governance through sustainability certification for commodity chains. Scholars describe these certification programs as “non-state market driven governance" (Cashore, 2002), while others prefer the term “transnational private regulation” (Bartley, 2007). In this context, an organizational field has emerged of competing transnational sustainable forestry certification programs. These programs work to institute sustainable management practices and chain-of-custody tracking in forest-based commodity chains, but failed to impact illegal timber harvesting. Among these, the Forest Stewardship Council (FSC) has earned the most legitimacy as a governance regime administered by private actors outside the state.

Section 6.3 examines how the FSC gained legitimacy and emerged as a source of normative authority with influence over other forest certification regimes. This is enabled by the spread of experimentalist governance architectures through the field of private forest certification.

In Section 6.4, I discuss how the field of private forest certification regimes is linked to the proliferation of public regimes for legality verification in the global timber trade. Despite the growth of private transnational regulation for forest governance, no single regime has been sufficient to cover the comprehensive scope of multilateral proposals such as the 1989 ITTO proposal for sustainable forest certification and the 1992 proposal for a global forestry treaty at the Earth Summit in Rio. One important issue area in which private forest certification has been ineffective is the illegal timber trade. Throughout the late 1990s and early 2000s, activists began lobbied for legislative action to address the illegal timber trade. Governments in Europe and North America responded with regulatory rules that require importing firms to perform legality verification on their timber supply chains.

In Section 6.5, I examine global forest governance as a regime complex. Global governance has evolved to include a network of overlapping public and private regimes that use the tools of product certification to constrain the behavior of governments and firms in timber-based supply chains. Drawing from the literature on regime complexes and experimentalism offers a useful analytical framework for understanding the interactions between public and

private regimes. Government initiatives to regulate illegal timber trade have drawn from the field of private forest certification to model their multi-stakeholder decision-making processes and chain of custody tracking systems. This is best exemplified by the US Lacey Act Due Diligence Consensus Standard and the European Union Timber Regulations. At the same time, private certification programs have adopted states' definitions of "legality" in the timber trade. Such interactions between public and private regimes demonstrate the potential for coordination and convergence in a regime complex, and the spread of experimentalist governance architectures may facilitate this.

6.1 An overview of major trends in global environmental governance

This section provides a broad overview of the evolution of global environmental governance. I review major changes stemming from the increased participation of non-state actors, which have produced led to the rise of "private" or "market-based" regimes like product certification programs, which operate alongside state-centric intergovernmental regimes like legally binding treaties as well as domestic laws.

Waning state centricity and multi-actor participation

Over the last forty years, researchers in international relations and contentious politics have observed the decline of "strong states" (Rosenau, 1993; Tilly, 1993) and a turn away from legally-binding treaties (Biermann, 2007; Biermann and Pattberg, 2008). Since the late 1980s and early 1990s, Westphalian state sovereignty has increasingly accommodated multilateral and supranational levels of authority (Rosenau, 1992; Tilly, 1993). International institutions (Young, 1997), "global civil society" (Tarrow, 1998; Wapner, 1996), and transnational corporations (TNCs) (Benner et al., 2005) have all become more politically significant in their ability to influence transnational regulatory problems. In addition, transnational contentious politics have pushed the boundaries of authority even further. Non-state actors have gained influence in the intergovernmental system, curtailing states' monopoly over the traditional post-World War II arrangements of intergovernmental regimes, treaties, and organizations (Meyer and Tarrow, 1998). Even as states have remained the primary form of political organization in international policy arenas, state-centric regimes depend importantly on the consent and participation of transnational non-state actors.

A number of avenues now exist through which non-state actors are influential. The authority of non-state actors is no longer solely expressed through lobbying and advising governments. Other channels of influence include providing policy research and technical reports, monitoring the commitments of states and industry, engaging in agenda setting, and formulating decision-making rules and procedures (Biermann, 2007; Pattberg, 2005). The importance of these non-state governance mechanisms has led some scholars to draw the distinction between governance done by the state and governance with or without government—underscoring the ability of non-state actors to design and administer governance regimes (Cutler, 2002; Rosenau, 1992). Non-state actors also exert authority in less direct ways. For example, Risse (1999) argues that domestic social movement activists can influence government officials

and international institutions who do not share their ideological positions by generate the ideas that constitute the powerful frames of world culture (see Risse, 1999).

To some degree, states have helped to facilitate multi-actor participation by establishing a kind of "coral reef" of international institutions (e.g. the United Nations, NATO, the European Commission) (Tarrow, 1998). The intergovernmental system has provided non-state actors with the incentives, opportunities and resources needed to build transnational coalitions that coordinate domestic and international policy interventions (Keck, 1998; Tarrow, 1998). For example, Keck and Sikkink (1998) describe how environmental NGOs help coordinate "transnational advocacy networks" (TANs) involving domestic social movement activists that push powerful actors such as the World Bank and US government to adopt internationally accepted environmental policies. TANs have arisen in policy arenas where states have failed to address effectively problems such as environmental protection, human rights, the status of women and children, and education (Meyer and Tarrow, 1998). The private authority of civil society groups and business entities, such as environmentalist alliances, scientific networks, and business associations, is now apparent in a range of transnational policy arenas (Conca, 1995; Corell and Betsill, 2001; Levy and Newell, 2005; Wapner, 1996).

Waning state centricity and increased "multi-actor" participation reflects a wider transformation of political authority and governance strategies in GEG. Power is decentralized and more fragmented (Biermann et al., 2007; Conca, 2005). The public authority of state actors remains, but even state-centric regimes and intergovernmental bureaucracies act increasingly as non-state actors in their own right (Biermann and Bauer, 2004). The resulting governance architectures can reach vertically through multiple jurisdictions and horizontally across multiple issue areas. These developments involve a general shift from purely public regimes to market-based regimes comprised of public and private actors (Falkner, 2003).

Public and private regime configurations in complex multilateralism

Non-state actors have transformed GEG by shifting state-centered multilateralism to what Bäckstrand (2008) refers to as "complex multilateralism:" a society-centered form of multilateralism. Unlike intergovernmental agreements between sovereign states, complex multilateralism entails regime formation from partnerships between varying combinations of state actors and non-state actors. Under complex multilateralism, regimes exhibit hybrid forms of public and private political authority and more networked architectures. The regimes that come together under complex multilateralism render GEG into a web of horizontal and vertical linkages (Lemos and Agrawal, 2006,). As O'Neill et al. (2013) show, in networked governance architectures, cooperation and influence operates between institutions that stretch vertically across different levels of governance and horizontally across different issue areas, compared more traditional intergovernmental regimes that involve hierarchical, centralized, top-down modes of steering. This networked architecture implies a multiplicity of entities with overlapping jurisdictions (Ansell, 2000) attempting to achieve what no single entity can achieve on its own (Witte et al., 2000).

Complex multilateralism can cover an array of configurations, involving different combinations of public and private regimes. For example, state-centric governance initiatives

between states can take the form of bilateral agreements as well as informal agreements that governmental officials strike with foreign counterparts in similar ministries to address transnational regulatory issues collaboratively. Unlike formal multilateral rulemaking and negotiations, these regimes rest on "good-faith agreements" between "like minded" regulatory agencies (Slaughter, 2004). By forming "transgovernmental networks," officials can by-pass executive or legislature decision-making to enforce global policy informally, for example the Basel Committee on Banking Supervision is an agreement between the heads of twelve central banks (Slaughter, 2004). Other examples may be found in various technological cooperations such as the US-led Carbon Sequestration Leadership Forum, in which governments agree to collaborate on innovation to address climate issues outside the Kyoto regime (Bäckstrand, 2008). There are also agreements at the sub-national level between regional governmental entities or cities would also fall under this category, such as the US Regional Greenhouse Gas Initiative.

Public-private regime configurations involve institutionalized cooperation between governments (or their intergovernmental organizations) and non-state actors (Pattberg). Such strategies are often used circumvent the implementation and legitimacy challenges involved in creating multilateral treaties (Haas, 2004). They often emerge under the leadership of well-funded non-state entities but require the support of government institutions. Implementation and enforcement of these regimes depends on market actors or on the diffusion and uptake of norms. The role of the state varies, from supporting non-state actors by creating new institutions, to providing critical resources, to co-opting private actors in state-led governance (Bäckstrand, 2008).

There are many examples of this configuration. One general category here are western development agencies working with international organizations, firms, and NGOs use private contractors to provision public goods in areas of scaled-back statecraft, like public health, development and environment (Beisheim 2008; Borzel and Risse 2010).[140] Other examples can be found in efforts to develop emissions trading regimes for the global carbon market; corporate actors partnered with states to create entirely new markets and commodities designed to contribute to climate policy goals (Matthews and Paterson, 2005). Public-private regimes often take the form of a commission (e.g. Commission on Sustainable Development; the World Commission on Dams). The World Commission on Dams (WCD), a multi-stakeholder body of scientists, advocacy organizations, and businesses, conducted assessments, devised new standards for the construction of new dams, and worked to institutionalize those standards at the national level. Governments provided the funding and data needed to complete the technical assessments, which served as the foundation for WCD's work (Conca, 2005).

Finally, there are private regime configurations that exert regulatory pressure without the direct involvement of government institutions. Rather than rely on states to define or enforce rules, corporations and/or civil society groups develop rules on their own initiative, and enforcement occurs through monitoring and information sharing. These regimes specify minimum standards for managing environmental and social issues in a business context. Compliance is voluntary, incentivized by the expectation that participation can enhance a firm's

[140] Such governance arrangements can be distinguished from the kinds of public-private partnerships that emerge within domestic setting, which have some kind of centralized accountability typical of domestic contracting arrangements (Bäckstrand, 2011).

reputation by increasing transparency with supply chain partners, investors, governments and the general public. Firms that comply may obtain certification from accredited auditors that grant participating firms the right to use the regime's logo in product marketing. The rules of private regimes have transnationally reach, operating in non-territorial spaces that run parallel to public institutions (Ruggie, 2004; Cutler, 2002,). Like state-led intergovernmental regimes, private regimes can create collective goods and reduce transaction costs associated with information and uncertainty (Pattberg, 2005).

Scholars distinguish between two broad categories of private regimes in GEG: industry self-regulation and transnational private regulation. Industry self-regulation is a collective response among firms, usually consisting of third-party auditing systems and industry codes of conduct designed by industry for industry (Pattberg, 2005; Gereffi et al., 2001; Garcia-Johnson, 2000). For example, the ISO 14001 Environmental Management System developed by the International Standards Organization specifies how to manage production processes to reduce environmental impact. Similarly, the Responsible Care program is a global, voluntary a code of conduct for corporate social responsibility, developed autonomously by the chemical industry for the chemical industry. However, purely private-private regimes are rare, as governments typically support these regimes in a number of direct or indirect ways (Falkner, 2003). For example, several governments and international organizations endorse ISO 14000 standards for environmental management through their own regulatory initiatives.

Transnational private regulation operates through the market to regulate industry performance without state authority, embodying what Cashore (2002) calls a "non-state market-driven" (NSMD) approach to global governance. Yet unlike industry-led initiatives, regime formation is motivated by the explicit goal of advancing social and environmental ends (Cashore et al., 2007; Bartley, 2007b). These regimes are also distinct from location-specific certification programs, such as organic certification programs, because they target multiple scales. For example, the Forest Stewardship Council (FSC) certification system for sustainable timber production and the Fair Labor Association (FLA) certification system for "sweat free" apparel (Sabel et al., 2000; McNichol, 2002) have transnational, multi-level reach through global supply chains. The FSC-style of transnational private regulation has become a popular institutional response to GEG problems (Bartley, 2007a; Bartley, 2007b; Cashore et al., 2007). Similar certification systems modeled after the FSC exist for mining, tourism, coffee, fisheries, food production, and most recently, biofuels (Cashore, 2002; Pattberg, 2005). Certification systems depend on incentivizing firms to participate is the ability to access markets where consumers are willing to pay a price premium for products with certification labels. However, consumer demand is usually not enough to drive participation in these regimes. Watchdog organizations often play an important role by mobilizing boycotts and other kinds of pressure-campaigns against those who choose not to participate, or conversely to endorse 'good market actors' and responsible firms that do participate (Sabel et al., 2000).

Transnational private regulation is not limited to product-focused certification programs and constitutes a dynamic category of governance that is still very much in the making. Other institutional forms have been used to push environmental and social "hard law" without relying directly on state authority. For example, the Coalition for Environmentally Responsible Economies (CERES) brings together institutional investors and environmental NGOs to pass

shareholder resolutions that pressure corporate boardrooms to adopt long-term environmental performance commitments (Pattberg, 2005). Like the product certification regimes above, the primary rationale of these regimes is not to improve the reputation of firms, but to create market signals that reverberate widely enough to change industry-wide practices.

Regime complexes and experimentalist governance

In some policy arenas, international relations scholars have interpreted the diverse configurations described above as a regime complex: "a collective of partially-overlapping regimes" (Raustiala and Victor, 2003). Traditionally, regime complex theory has conceptualized regime complexes as comprised of parallel interstate arrangements that generate legally binding rules (Aggarwal, 1998; Alter and Meunier 2009; Oberthür, 2011). A subset of scholars has applied the concept more flexibly to include actors and rules involved in "soft law" governance initiatives led by private sector firms and civil society groups (Abbott, 2011; Keohane and Victor, 2011). For example, Abbott (2011) describes the "Cambrian explosion" of state and non-state regimes in climate change governance, which vary widely in terms of their constituent actors, activities and scales of operation.

Architecturally, the component regimes in a regime complex may appear nested, overlapping, or loosely connected (Abbott, 2011; Keohane and Victor, 2011). In the absence of nested hierarchy, overlapping or loose connectivity, parallel regimes are not considered part of a regime complex. Nested regimes are hierarchical to some degree, with at least one institution exerting authority over others in their ability to resolve conflicts or inconsistencies between rules. Such features are apparent in regime complexes comprised of bilateral trade agreements that sit beneath the authority of the WTO. Overlapping regimes exert authority over the same set of issues without hierarchical relationships.

For example, the climate governance regime complex comprises a diverse assemblage of governance forms, including inter-state arrangements, to transnational institutions, legally-binding rules, implementation mechanisms, financing arrangements, and operational programs working to address different dimensions of climate change adaptation and mitigation at different scales (Bulkeley and Newell, 2011). Abbott (2011) argues that institutions in this regime complex are weakly nested under the United Nations Framework Convention on Climate Change (UNFCCC). By contrast, Keohane and Victor (2011) see the climate change regime complex as lacking any overall architecture with no identifiable center hierarchy and little overlap. Instead they argue that a handful of institutions are "loosely coupled" by a shared focus on impacting climate change.

Keohane & Victor (2011) assert that while multilateral interstate regimes are still possible, regime complexes are more likely to emerge in certain contexts. Treaties prove advantageous in situations where a majority of powerful actors have common objectives that can be achieved with some degree of certainty, through a single international institution, such as regulatory compliance monitoring, enhanced information sharing, or reduced contracting (Keohane and Victor 2011). But in policy arenas characterized by high uncertainty and diverse interests, the treaty structure can prove limiting and a regime complex may be more likely to emerge. For example, in the case of climate change, creating UNFCCC and the Kyoto Protocol has been

challenging given the difficulty of secure binding climate policy commitments from governments (Keohane and Victor, 2011). For governments, a binding framework can present obstacles for change, for example if framework goals are based on unrealistic expectations or when new information emerges that demands a change of course. Compared to the potential rigidity of multilateral institutions, the structure of a climate regime complex accommodates multiple strategies that can be adjusted over time with less difficulty. Moreover, the multi-level structure of a regime complex accommodates a diversity of policy approaches that can span multiple jurisdictions, from local and subnational governments, to nation states, up through the supranational and transnational levels.

Despite these advantages, regime complexes can prove dysfunctional. In regime complexes that are weakly nested or only loosely coupled by a shared focus, inconsistencies between regimes may emerge that undermine the efficacy of one or more regimes in the regime complex. Actors may even intentionally create inconsistencies between regimes by "regime -shifting" in order to encourage "forum-shopping" by a target audience (Murphy and Kellow, 2013; 2004; Abbott, 2011). Without some hierarchical authority, inconsistences between regimes can undercut regulatory efforts throughout the entire regime complex.

The theory of experimentalist governance offers one explanation for how rule conflicts and inconsistencies may be resolved in a regime complex. Experimentalism represents a pragmatist style of governance, like that advocated by John Dewey, in "ongoing reciprocal readjustment of ends and means" and general treatment of all solutions as incomplete (Zeitlin, 2015: 2). There are diverse forms of experimentalism, but key characteristics of experimentalist governance include a polyarchic structure involving some combination of "central" and "local" units (Dawson, 2015). In experimentalist governance, the central intent is to govern through a process of "learning from mistakes" (Sabel, 2012). A central entity monitors the performance of local entities and compares between entities. This form of peer review serves as a key coordinating mechanism. Local entities have the autonomy to pursue overarching framework goals (e.g. "sustainable forests," "adequate education," "good water quality and access"), but by evaluating their performance against similar entities, there is pressure to continually improve.

To review briefly here, experimentalism involves four procedural cornerstones: participatory goal setting, benchmarking, peer review and reflexive learning/revision (Cohen and Sabel 2006, p. 774; Sabel and Simon, 2011, p. 79; Sabel and Zeitlin, 2011). Participatory goal setting brings relevant stakeholders together to engage in deliberative process of setting framework goals by identifying what problems need solving, what collective goals need realizing, and what measures should be taken in pursuit of said goals (Sabel, 2012). Participatory goal setting can occur in a top-down manner (as is often the case in implementing federalism) or through consultation between diverse stakeholder organizations.[141] In either case, metrics are established to monitor achievement towards the broader framework goals, and local units act autonomously to implement collective goals on the ground. Second, benchmarking displaces the

[141] When this process is spearheaded by a regulatory agency like the US Environmental Protection Agency (EPA) or the European Commission (EC), participatory goal setting occurs in a top-down manner. However, it can also occur through consultation or deliberative interactions among local units that are relatively homogenous or diverse, including various public and private entities, branch organizations, and territorial authorities (Sabel and Simon, 2011; Cohen and Sabel, 2006).

need to dictate decisions to local units. Instead, local units supply the information required to report-back their performance, which contributes to the third procedural cornerstone of experimentalist governance: peer review (Sabel, 2012). Peer review highlights the leading versus lagging entities' performance. This requires some kind of reporting and evaluation system to pool monitoring information (Sabel and Simon, 2011). Fourth, and finally, peer review enables reflexive learning and the revision of framework goals or strategies to achieve framework goals, corresponding metrics and decision-making procedures (Sabel, 1994). Depending on the regime design, there may be additional pressure on laggards to ratchet up their performance. These incentives may take the form of "coercive sticks" or "enticing carrots" (Sabel and Simon, 2011, p. 79-82). The most developed forms of experimentalism entail recursive learning processes take place across a multi-level architecture (Sabel and Zeitlin, 2012). Regardless, what is important is that the regime architecture is able to respond to change and uncertainty.[142]

Since the 1990s, experimentalist governance architectures are increasingly found in a variety of public policy venues, from government agencies, to networks of national regulators, to cooperative operations involving government officials (Sabel and Zeitlin, 2008; 2010). In the EU, experimentalist institutions emerged from the need to coordinate the diverse national practices of member states (Sabel and Simon, 2011). They can be found broadly in EU regulations, including energy, telecommunications, financial services, competition, food and drug safety, data privacy, environmental protection, justice and internal security, anti-discrimination, and fundamental rights (Sabel & Zeitlin 2011). In the US, the rise of experimentalism has paralleled the unpopularity of "command-and-control" approaches.[143] US experimentalist institutions can be found in sectors where technological and economic change outpaced established public protections, such as nuclear safety, food safety and environmental pollution (Sabel and Simon, 2011). US experimentalist institutions can also be found in the public administration of services that are plagued by strategic uncertainty due to reform interventions, like public education and child protective services (Sabel and Simon 2004).

Experimentalism also appears in an array of transnational governance regimes for issues like the environmental sustainability of forests, fisheries and other primary commodities, as well as disability rights, data privacy, food safety. Private transnational regulation programs like the FSC and ISO 14000 follow a process of benchmarking, monitoring, peer review, certification and recursive revision. These regimes may target firms or national and subnational governments, which adapt transnational standards to their unique context and report back performance using the program's standard set of metrics. Peer review can take a number of forms. For example, auditors may grant a facility certification or a governing council may assess where performance improvements are needed. Depending on the regime, recursive learning may be more or less

[142] These procedural cornerstones can occur successively, although in some case they do not—as in the EU's REACH regulation (Registration, Evaluation, Authorization and Restriction of Chemicals) (Biedenkopf, 2015).
[143] In this context, experimentalism should be understand as distinct from "minimalism"—another popular alternative to expert-led rule-bound, bureaucratic regulatory action, famously associated with legal scholar and Obama Administration appointee, Cass Sunstein (Sabel and Simon, 2011). Minimalism as a governance strategy is oriented towards efficiency and grounded in behavioral economics. The resulting regulatory institutions often involve bureaucratic elites, cost-benefit analysis and marketable rights and duties, like emissions permits and welfare vouchers. By contrast, US experimentalism is grounded in management theory and the democratic philosophy of John Dewey, which emphasizes learning and adaptation to achieve democratically defined goals (Sabel and Simon, 2011).

robust. For example, the governing council of the FSC requires increasingly stringent performance benchmarks be met over time in order to maintain certification, thereby enforcing a process of "ratcheting upwards." Others, like the ISO 14000, allow firms to set their own pace for meeting self-imposed milestones.

To the extent that a regime complex has a number of experimentalist regimes, the experimentalism can serve as a coordinative architecture. When a regime complex is only weakly nested or when there is no single actor that can exert hierarchical authority in resolving rule conflicts, experimentalism may enable a leading regime to influence a lagging regime. As Sabel and Zeitlin (2011, p. 2) explain:

> Experimentalist governance appears particularly well-suited to transnational domains, where there is no overarching sovereign with authority to set common goals even in theory, and where the diversity of local conditions and practices makes adoption and enforcement of uniform fixed rules even less feasible than in domestic settings.

In the next section, I show how each of the above trends in GEG has taken shape in context of global forest governance. In the concluding section of this chapter, I return to the discussion of regime complexes and experimentalism to examine questions about the relationship between public and private regimes operating in the regime complex for forest governance.

6.2 The emergence of global forest governance, the limits of multilateralism, and multi-actor participation

Forests emerged as a subject of global environmental governance in the early 1980s. International concern for deforestation grew with the publication of forest surveys and assessments in the 1980s that revealed that the rate of deforestation was accelerating. Between 1970 and 1994, global consumption of forest products increased by a third due to new demand from industrializing countries (Dudley et al., 1995). At the same time, a complex set of changes was underway in many of the leading timber-producing countries, including the expansion of export-oriented agribusiness following the implementation of structural adjustment policies, oil production, industrial development projects, population movement, civil wars and military operations (Humphreys, 1996). Tropical deforestation was of particular concern, as opposed to temperate and boreal forests (although the latter would eventually begin to receive more attention in the late 1990s). Like other transboundary environmental problems such as ozone depletion and marine pollution, tropical deforestation gained status as a global issue with an international political agenda over the course of the 1980s.

The Tropical Forestry Action Programme (TFAP) was the first major initiative organized to address tropical deforestation. In the early 1980s, the Food and Agricultural Organization (FAO) of the United Nations and the Washington D.C.-based NGO, World Resources Institute (WRI), organized the Tropical Forestry Action Programme (TFAP) (Humphreys, 1996). TFAP constituted a broad-based coalition of bilateral development agencies, the World Bank, the United Nations agencies, governments, international NGOs and local NGOs committed to reversing tropical rainforest destruction. Throughout the late 1980s, TFAP activities came under intense criticism from both industrialized and developing nations, leading to prominent members

refusing to make further financial contributions (Humphreys, 1996, p. 40-46). At a 1997 meeting, the G7 urged the TFAP to strengthen its emphasis on forest conservation and biodiversity protection. Later that year the World Wildlife Fund withdrew support, citing pressure from developing country affiliates that felt the RFAP would do more harm than good. Despite a lengthy restructuring process, TFAP dissolved within the FAO. It was soon after superseded by Chapter 11 of the UN Conference on Environment and Development's (UNCED) Agenda 21, which called on all governments in tropical and non-tropical countries to implement forestry management programs.

The International Tropical Timber Agreement of 1983 (ITTA) and the International Tropical Timber Organization (ITTO) emerged alongside the TFAP to push national governments to take ecological considerations seriously in the development of their forest policy. During the intergovernmental Meeting on Tropical Timber at the UN Conference on Tropical Timber in 1983, member states created the ITTO to ensure implementation of the ITTA. The International Union for Conservation of Nature (IUCN), an international NGO, was especially forceful in pushing for the ITTO to take seriously Article 1(h), which directs states to develop national policies aimed at the "sustainable utilization and conservation of tropical forests and their genetic resources" (Humphreys, 1996, p. 55-57).

Yet, by the late 1980s, NGOs like the British group Friends of the Earth (FoE) alleged that the ITTO had rejected implementation projects that proposed to contribute meaningfully to Article 1(h) based on political considerations. Despite negligible efforts to fund Article 1(h) projects, ITTO research helped launch an important debate about what constituted sustainable forest management. These debates catalyzed action in the NGO community (Humphreys, 1996, p. 67-70).

Non-state actors as catalysts for transnational private regulation over forests

Frustrated by government efforts to curb tropical deforestation, environmental NGOs (hereafter "ENGOs") launched public campaigns in the mid-1980s that linked high profile businesses in the United Kingdom, the Netherlands, Germany, the United States, Japan and Australia with the destruction of tropical forests.[144] These campaigns involved radical protest demonstrations and boycotts against market actors who had the power to exercise preferential purchasing in supply chains linked to deforestation. For example, Rainforest Action Network (RAN) in the United States boycotted Burger King for its use of beef sourced from land that had been converted from tropical forest to cattle pasture, leading Burger King to cancel millions of dollars in beef contracts in Central America after its sales dropped 12 percent during the boycott (McNichol, 2002). Friends of the Earth (FoE) in the United Kingdom linked UK timber companies to tropical deforestation and subsequently launched a boycott against UK retailers selling wood products from virgin rainforests (Dudley et al., 1995, p. 204). In response, timber industries began labeling their products with environmental and social claims about the effect of

[144] Environmental NGOs like Friends of the Earth (FoE), Greenpeace, and Rainforest Action Network (RAN) orchestrated a series of radical protest actions and demonstrations against retailers in the United Kingdom, the Netherlands, Germany, the United States, Japan and Australia. The World Wildlife Fund (WWF) took a slightly different approach than boycotts, by pressuring companies to join "buyers' groups" committed to selling sustainable timber.

their business practices on forest conservation. ENGOs and other watchdog organizations attacked industry claims as unsubstantiated and lacking in transparency and credibility.

In order to adjudicate industry claims, FoE issued the first major set of authoritative definitions of best practices in sustainable forest management. FoE published its first edition of the "Good Wood Guide" in the UK in 1987, which identified specific tropical forests, like teak plantations in Java, Thailand and Burma, rubber wood plantations in Malaysia, and others as sustainably managed. In addition, FoE awarded downstream companies that sourced wood from these forests with a Seal of Approval. By attaining a FoE label, firms could communicate their product materials originated in 'sustainably managed' forests, which in turn would allow big retailers to identify supply chain partners engaged in sustainable practices. In 1988, the FoE began discussions with the UK government about how to scale their approach.

With strong support from the UK Overseas Development Administration (ODA), the FoE proposed a timber certification program run by the International Tropical Timber Organization (ITTO). As an intergovernmental body established by the United Nations Conference on Trade and Development (UNCTAD) to oversee the timber trade, the ITTO was well positioned to implement and oversee a labeling program for sustainable managed forests (McNichol, 2002). In 1989, the UK delegation to the 7th session of the ITTO proposed that the FoE's forest product eco-labeling scheme as a formal ITTO initiative. The ITTO produced a set of best-practice guidelines for sustainable forest management modeled after the FoE's guidelines. Yet the proposal to create an ITTO certification program was extremely controversial. Many ITTO members were unwilling to support the certification criteria, despite having been accepted by major ENGOs and other social-environmental groups (Gale, 1998, p.158-176). For example, some critics questioned the lack of criteria for identifying which forests were "ecologically benign."

However the FoE/UK proposal for a certification program run by the ITTO stalled. There was disagreement between ITTO members on certification criteria, and fierce opposition from delegates from timber-exporting countries like Malaysia, Indonesia and Cameroon (Bartley, 2007a). These countries objected on the grounds that ITTO certification would create unfair barriers to international trade under the General Agreement on Tariffs and Trade (GATT) (Bartley, 2007a). Although the FoE/UK proposal for ITTO certification failed, the ITTO's efforts to translate the FoE principles into criteria and indicators for forest certification provided a foundation for future certification initiatives and demonstrated an important lesson-learned: for any future internationally-agreed upon certification program to succeed, standards and criteria defining "sustainably managed" would require consensus from diverse forest industry stakeholders (Synnott, 2005; Tollefson et al., 2008).

ENGOs shifted their strategy for substantiating industry claims regarding timber sources practices by adding certification program development to their existing efforts to organize boycotts and pressure government for intergovernmental inaction. Boycotts had become less effective at stopping unsustainable practices, and ENGOs sought more constructive alternatives that would support forest communities in the developing world (McNichol, 2002; Bartley, 2007a). Although the FoE discontinued use of its Seal of Approval in 1990, the US-based Rainforest Action Network launched a new program based on the guidelines established by the

ITTO based on the FoE proposal. The program certified teak from Papua New Guinea for a high-end furniture manufacturer. In the absence of more elaborate, broadly accepted standards, it only certified for three criteria. Another for-profit certification program emerged that mimicked the RAN certification program known as the "Green Cross"(McNichol, 2002, p. 134-5).

WWF-UK also began experimenting with certification program with the leading British retailer, B&Q. WWF-International had been focused on developing "buyers groups" of retailers committed to sourcing timber from WWF-approved forests, with WWF-UK, WWF-Sweden and FoE-Netherlands working to push industry representatives in their respective countries to develop responsible purchasing policies and join buyer groups.[145] The WWF-UK certification program with B&Q could be scaled to these buyers groups. The program drew participants quickly. Within a year, other major British retailers had joined the WWF-B&Q initiative. In 1990, a group of timber traders in the US committed to sourcing sustainable timber called the Ecological Timber Company (ETC) approached WWF-UK to discuss broadening the initiative further. ETC had worked previously with RAN in the US to identify a set of 'sustainably managed' forests in Papua New Guinea and the Solomon Islands, but felt a credible international body that could endorse sustainable timber was needed. To support ETC's efforts, WWF-UK and B&Q committed financing (McNichol, 2002, p. 134-5).

The ETC/WWF/B&Q collaboration to develop international forest certification ignited a new multi-stakeholder initiative. The group presented its proposal for an independent forest certification organization at the founding conference of the Woodworkers' Alliance for Rainforest Protection (WARP) in 1990. WARP formed in 1989, consisting predominantly of American and Canadian woodworkers, community forestry workers, wood importers, environmentalists, foresters, environmental scientists and members of Rainforest Alliance—all interested in developing a way to validate industry claims about forest management practices (McNichol, 2002). Firms and ENGOs that had once been opposing parties in boycotts against tropical timber were now collaborating on a plan for a voluntary, international certification system, which would become the "Forest Stewardship Council."

Persistent limitations in the intergovernmental system

Alongside certification, ENGOs continued to advocate for intergovernmental solutions to deforestation. ENGOs, governments and grassroots groups maintained that forests are a global public good, worthy of protection in the face of global climate change, biodiversity loss, and soil erosion (Humphreys, 1996, p. 5-15).[146] ENGOs' lobbied for an international agenda that linked powerful media images of rainforest destruction in the Amazon to scientific consensus on the causal links between deforestation, atmospheric CO2 and climate change (Humphreys, 1996: 15-18). The United Nations Food and Agricultural Organization (FAO), the UN Development Program (UNDP), and the World Bank (WB) agreed that multilateral collaboration was necessary to promote forest conservation (McNichol, 2002).

145 WWF-UK WWF-Internaitonal WWF-Sweden and FoE-Netherlands were particularly instrumental in pushing industry representatives to develop responsible purchasing policies and join buyer groups.
146 For example, the Rubber Tappers' Association of Brazil was a grass-roots group from Brazil that orgaznied against deforestation in the 1980s, led by the Brazilian forest activist Chico Mendes.

Yet, negotiating a global forest treaty proved encountered unique obstacles that had not plagued multilateralism for global environmental issues like ozone protection and marine pollution. In 1990, the FAO recommended that a treaty be concluded in time for the 1992 UN Conference on Environment and Development (UNCED) in Rio de Janeiro (the "Earth Summit"). However, negotiations failed to launch, largely due to mistrust of the FAO (Parson et al., 1992, p.12-15, 34-36). The UNCED Preparatory Committee included a forest treaty on its agenda, but in the lead up to the 1992 Earth Summit, disagreement emerged over the focus of such a treaty. Developing countries and developed countries disagreed forcefully over the proper balance between global responsibility and state sovereignty (Cashore and Bernstein, 2004). Developed countries wanted to focus on tropical rain forests. Developing countries, led by Malaysia, insisted on the inclusion of temperate and boreal forests (Parson et al., 1992). These forest producers further argued against any binding agreement on the grounds that conservation requirements would stifle national economic development (Bernstein and Cashore, 2007).

Parties to the Earth Summit failed to produce a binding global convention, despite the fact that forests took center stage at the meeting (Parson et al., 1992). In lieu of a treaty, participants signed a "Statement of Principles" in the eleventh hour, which included 17 non-binding principles for forest management, conservation, and sustainable development for all forest types (tropical, boreal, and temperate forests). The principles struck a balance between forest management, conservation, and sustainable development, by emphasizing a combination of measures to increase forest cover through conservation, reforestation, and afforestation alongside the need to consider the multiple uses of forests for sustainable development. Some delegations supported including a statement calling for a future treaty. However, the final document committed governments to the future task of considering the potential for intergovernmental cooperation based on the adequacy of the Statement of Principles.

In the wake of a failed treaty, governments in Europe and the US attempted to move forward unilaterally. New legislation passed limiting tropical timber imports from poorly managed forests and plantations (Johnson and Cabarle, 1993). The Austrian parliament's ban on tropical timber imports in 1992 was the most ambitious of these governmental efforts. The ban only allowed for tropical timber that was labeled as sustainably produced. Indonesia and Malaysia complained the ban would increase import tariffs on tropical timber by 70 percent and threatened to challenge the law as barrier to free trade under the General Agreement on Tariffs and Trade (GATT) (Dudley et al., 1995; Bernstein and Cashore, 2007). In 1993, the Austrian government backed down and revised the law, discouraging other governments from taking a similar route (Bartley, 2003, p. 103).

Global trade rules imposed major constraints on both multilateral and unilateral initiatives to build transnational governance institutions for forests. The Earth Summit took place at the tail end of the Uruguay Round, the largest trade negotiation in history. During this time, representatives from 123 governments were locked in intense negotiations on trade and agriculture. The marathon seven-year negotiation began in 1986 and concluded in 1994 with the creation of more expansive global trade rules under the World Trade Organization (WTO), which replaced the General Agreement on Tariffs and Trade (GATT). Clashes ensued over the extent to which environmental regulation could interfere with free trade, but parties pushed ahead to support the case for greater liberalization.

Given the limitations imposed by trade liberalization on intergovernmental and government action, ENGOs threw greater weight behind private certification. Governments also supported this turn toward a "private" solution. In the next Section 6.3, I look at the emergence of the FSC as the first transnational private regulatory regime for forests.

6.3 Private Regimes for Forest Governance: Certification programs for sustainably managed forests

In this section, I discuss key features of the FSC before examining the rise of industry certification programs that compete with the FSC. I also use the concepts "organizational fields" and "structuration" to explain how the competition between the FSC and competing industry programs has generated a shared notion of legitimacy in forest certification. I discuss FSC enduring role as a normative authority in the field of forest certification.

Institutional entrepreneurs and the FSC

With the setbacks in intergovernmental and governmental fora, ENGOs, governments, and large firms committed their support to the WARP Certification Working Group's FSC as the only remaining viable regime for global forest governance. At the 1990 WARP conference, attendees had converged around a proposal to create a joint industry-environmentalist watchdog organization that could credibly monitor forest management practices and validate timber company claims (Cashore et al., 2004). The WARP Certification Working Group set out to develop the "Forest Stewardship Council" as a kind of umbrella watchdog organization tasked with administering the certification system. The FSC would provide accreditation to other third-party certification bodies, but not certify forests itself. A number of governments provided direct support to the WARP initiative after unilateral initiatives failed. The WWF-Austria convinced the Austrian government to reallocate public funds that were previously budgeted for its timber labeling legislation (approximately $1.2 million) to the WARP's planned initiative (Bartley, 2003, p. 103). Other European governments followed suit, in part as a strategy to appease public pressures for forest governance without violating global trade rules. The UK maintained an interest in a binding global forestry agreement but also supported the WARP initiative (Cashore et al., 2004). Specifically, the UK Forest Authority outlined domestic and global practices for sustainable forestry, which included the development of criteria for private certification. Industry actors like ETC and retailers like B&Q also lent crucial support.

Major ENGOs like Greenpeace, FoE, and especially the WWF, acted as the lead "institutional entrepreneurs" of the FSC.[147] These ENGOs shepherded the WARP initiative from its inception as the WARP Certification Working Group through to the establishment of the FSC as an independent certification and watchdog organization (Bartley, 2007a; McNichol, 2002).

[147] Paul DiMaggio (1988) introduced this term to describe the activity underlying the creation of new institutions, explaining that "new institutions arise when organized actors with sufficient resources see in them an opportunity to realize interests that they value highly…[Institutional entrepreneurs] create a whole new system of meaning that ties the functioning of disparate sets of institutions together" (DiMaggio 1988: 14).

WWF, in particular, acted as the "midwife" of the FSC by taking on a number of roles (Bernstein and Cashore, 2007; Gulbrandsen, 2008). WWF-UK staffer, Francis Sullivan, drafted the first outline of the FSC charter. In addition, WWF-UK also channeled critical financial resources to the fledgling FSC by drawing on its existing network of large philanthropic organizations. After the MacArthur, Ford, and Rockefeller foundations provided seed funding, they helped raise money from over thirty major foundations to form a Sustainable Forestry Funders (SFF) network. As Bartley (Bartley, 2007a) explains, the SFF provided invaluable financial support that enabled the participation of key stakeholders, such as environmental and social movement organizations, in the FSC founding meetings. Finally, WWF-International developed a strategy around the creation of buyers' groups comprised of retailers like B&Q and Home Depot that pledged to adopt FSC standards into their purchasing policies once it was ready for implementation. This strategy would work to coerce downstream timber operators into obtaining FSC certification in order to sell to environmentally conscious consumers in higher value market segments for wood products.

The FSC as a democratic, multi-stakeholder association

The first responsibility of the FSC was to develop a transparent process for creating internationally accepted principles and criteria that could be implemented at a national scale (Synnott, 2005, p. 13). To do this, the FSC developed a multi-stakeholder decision-making model that brought together a range of interest groups to participate in rule-making. From the start, the FSC Founding Group prioritized obtaining as much support as possible from a diverse group of forest stakeholders. The task at hand was to devise principles and standards for sustainable forestry management practices that would be considered legitimate by industry actors and environmentalists alike. To do this, it was deemed critical that critical that no one particular interest group be able to dominate the General Assembly—the body responsible for setting the rules of the FSC as an international governance regime.

The FSC Founding Group held regional consultations in Brazil, Canada, Ecuador, Ghana, Malaysia, USA, Papua New Guinea, Peru, Sweden, Switzerland, and the UK, in 1992, to gather input in preparation for the first General Assembly meeting in October 1993. Specifically, it collected feedback on its draft mission statement, operational statutes, principles and standards. The draft principles and standards were written in accordance with the ITTO guidelines on sustainable forest management, the International Standards Organization, the International Labor Organization, national forestry laws, and global trade rules.

Through these regional consultations, the question of whether the FSC would be a foundation verses an open member association emerged as a controversial voting item for the upcoming General Assembly. The WARP Certification Working Group had originally conceived of the FSC as an open membership association, in contrast to other basic variants of multi-stakeholder processes: commissions and foundations (Dingwerth, 2008).[148] More radical

[148] In the commission and foundation model, access to decision-making depends on how the leadership initiates a decision-making process, including the selection of participants and the rules for deliberation and voting. In contrast, the association model is more straightforward in its commitment to open access and meaningful participation. Members of the association retain ultimate authority, but access to decision-making by members depends on how membership duties are defined and how potential voting blocs are institutionalized (e.g. distributing voting power to accomplish North-South parity).

stakeholders had pushed for the General Assembly to model itself as a multi-stakeholder membership association. However, critics had warned the working group that an open membership would complicate decision-making and be too expensive. In the revised draft, the FSC Founding Group proposed a traditional foundation ruled by a board of directors with no members (Synnott, 2005). Transnational environmental justice groups like the World Rainforest Movement opposed this change, arguing that a membership organization was needed to give decision-making power to local stakeholders like local forest residents, timber workers and indigenous peoples (Humphreys, 1996). The General Assembly organizers needed a clear mandate from participants on the issue in order to ratify the FSC charter documents.

At the 1993 inaugural General Assembly, the majority of assembly participants voted for a membership association, but there was significant disagreement over membership for future FSC General Assemblies. Representatives from many social and environmental NGOs in the global North objected to extending membership to commercial interests. However, once it became clear that indigenous groups and local stakeholders from the tropics did not completely oppose timber harvesting, a large majority supported opening membership for future FSC Generally Assemblies to all stakeholders, including industry (Synnott, 2005).

Membership would be divided into three statutory voting chambers: economic, social and environmental interests. To prevent economic interests from hijacking FSC decision-making, the founding assembly decided to assign each chamber equal voting weight on any changes needed to FSC principles and corresponding criteria. Together, the environmental and social chambers would constitute two-thirds of a statutory vote, ensuring the stringency of environmental and social rules over economic considerations. In addition, each chamber would have sub-chambers consisting of members from richer (developed or "Northern") countries and poorer (developing or "Southern") countries. Membership on the secretariat's governing board and national level initiatives would also follow this tripartite model.

Thus, at both the transnational and national levels, certification criteria and performance standards would be defined by a range of interest groups, with balanced representation between civil society (e.g. environmental and social advocacy organizations) and industry (industry associations and firms), and between the northern and southern timber trading interests (Cashore et al., 2004). This architecture aimed to ensure internal consensus among a membership that represented every relevant stakeholder group in the forest sector. However, it also introduced arduous decision-making processes.

Experimentalism in the FSC architecture

Administratively, the FSC organized itself according to an experimentalist governing style (See discussion on experimentalism Section 6.1). The FSC developed a form of experimentalism that takes place across a multilevel architecture. The FSC formalized its multi-level structure when it officially began operating in 1993. At the transnational level, the General Assembly and Board of Directors govern the FSC-International Secretariat (originally based in Oaxaca, Mexico, then relocated to Bonn, Germany). Every three years, the FSC General Assembly would meet to vote on any changes needed in the international FSC principles and corresponding criteria. This includes the FSC's operational procedures, broad principles of sustainable forest management and corresponding criteria for defining performance standards. Standards and

procedures would be first determined by deliberation, followed by supermajority voting. National or regional level FSC initiatives would then be responsible for translating the international principles and criteria developed by the General Assembly into local standards appropriate for that region.

National level initiatives form as satellites of the international FSC body or as independent NGOs with their own funding. In either case, a legal contract between the national FSC "contact persons" and "working groups" is established with the FSC International Secretariat is required. Sub-national, regional initiatives may form with the approval from the national level FSC initiative and the FSC General Assembly, as has been the case in Canada and the US. At all of these levels, FSC organizations are required to conform to the three-chamber model of multi-stakeholder deliberation and democratic decision-making.

Individual firms are able to obtain one of two kinds of FSC certifications from their national FSC initiative: The Forest Land Management certification for landowners and timber companies, and the Chain of Custody certification for companies that wish to process and/or sell wood from FSC-certified forest operations. For Forest Land Management certification, independent third-party auditors would verify FSC compliance every five years and conduct annual surveillance audits in the interim.

Auditing provides crucial data, not only for the purposes of granting certification but also for carrying out the experimentalist features of benchmarking, peer review, and recursive rulemaking at the higher levels. Audits would include review of forest management and planning documentation, firm financial data, and contracts for services (such as chemical applications). Auditors would also consult with local forest employees, NGOs, community leaders, resource managers, and local residents about the applicant's operations. For Chain of Custody certification, audits would be paper-based to assess whether the applicant's in management systems were adequate to track FSC certified material through the chain of custody (Auld et al., 2008, #66298). All of this data, theoretically, enables the FSC to carry out the last experimentalist procedures of recursive learning, in which the FSC evaluates the performance of entities across its multilevel system to pressure laggards and make needed changes.

Implementing FSC rules in timber-based supply-chains

The original intention of the FSC Founding Group was to certify all supply chains, from small scale community managed forests to large scale commercial operations, covering all types of forests, from natural forests, to heavily altered forests, to exotic plantations. The founding principles addressed tenure and use rights, community relations, worker's rights, environmental impacts, management plans, monitoring and preservation of old growth forests, and the use of plantations. However, a perception of large, commercial timber operations as incompatible with FSC principles spread during the General Assembly (Synnott, 2005; Tollefson et al., 2009). Indigenous advocacy organizations were aligned with this view, and others agreed that the bar for attaining FSC certification should be set as high as possible to ensure environmental and social goals would not be compromised (Humphreys, 2008). By designing high standards for small-scale community-based timber, FSC certification would elevate their role in the global market for wood, the General Assembly aimed to inhibit the participation of larger timber producers that were not willing make meaningful changes.

WWF, FoE, Greenpeace and other international ENGOs advocated for less stringent standards that would enable the participation of medium- and large-size commercial operations. These groups had already invested in a strategy of cultivating wood 'buyers' groups' in Europe and South America comprised of large corporate retailers. WWF believed that without larger timber producers, their buyers groups' demand for FSC certified wood would outstrip supply. Further, they argued that it would be more strategic to focus on the largest actors in the supply chain first. Enrolling commercial operations early on would establish a larger market for FSC-certified wood, which could eventually compete with non-certified wood. In practice, targeting supply chains comprised of medium and large timber operations meant less focus on timber firms from tropical forests in developing countries, which was had been the focus of combatting deforestation (Counsell and Loraas, 2002). Their proposal prevailed, conditioned by the expectation that over time, standards would become more stringent once FSC certified wood had gained ample market share.

Regime proliferation and competition from industry certification programs

Soon after the founding of the FSC, industry groups began setting up rival certification regimes. A handful of forest companies saw the implementation of sustainability management principles as an opportunity to reach environmentally conscious market segments, but most industry groups widely rejected the FSC process (Pattberg, 2005). Despite the open invitation to the founding FSC General Assembly, important industry officials refused to participate. Some felt deliberately excluded from these meetings. Smaller timber producers and land owners protested that national-level assemblies were inaccessible because participation in the process of translating FSC principles and criteria to regional contexts was too time-consuming (Cashore, 2002). They argued that poor industry representation was evident in the overly stringent founding statutes and principles. For example, large industrial forest companies in North America argued that FSC chain-of-custody tracking was ill-suited for the complexity of their forest products supply chains. In the US, about 57 percent of forestland is privately owned by approximately 11 million individual landowners. Although federal, state and municipal governments own the remainder of US forestland, these 11 million individual landowners are the source of timber fibers for 92 percent of the forest products industry (AF&PA, 2014). The logistics of tracking wood through for this population of private forest landowners would be too burdensome an undertaking (Cashore et al., 2003). By contrast, in countries like Sweden where industry supply chains are less complex, industry associations were more likely to participate in the FSC program rather than invest in competitor programs.

In both Europe and North America, industry shared a strong belief that the rules of certification would be better written by those implementing sustainable forest management. US industry officials justified the need for their own forest certification program on the grounds that the additional management activities required to attain FSC certification would be too burdensome (Cashore et al., 2004; Cashore et al., 2007). In addition, timber companies and forest owners worried that without a separate industry-friendly standard, the FSC process would engender an uneven patchwork of standards across different regions, burdening supply chain relationships and increasing operational costs (Cashore et al., 2004).

Timber operators and forest owners established their own sustainable forest certification programs to compete with the FSC. The Canadian Standards Association (CSA) created the Sustainable Forestry Certification program. The US American Forest and Paper Association (AF&PA) created the Sustainable Forestry Initiative (SFI). European industry groups created the Pan-European Forest Certification, later renamed the Program for Endorsement of Forest Certification (PEFC), which coordinates regional industry certification programs in European nations. PEFC quickly became the FSC's main competitor in Europe; by offering landowners a more affordable certification process, it has certified more hectares than the FSC (Cashore et al, 2004). The membership of the PEFC governing council includes twenty-five "National Governing Bodies" nineteen of which are European. The US SFI and the Canadian CSA became members of the PEFC council in 2000. Both SFI and CSA have been endorsed by the PEFC.

The market for certified wood continues to grow, even though certified wood remains a small percentage of wood traded globally. In 2013, the percentage of global forests with certification reached 10 percent (FAO/UNECE, 2013, p. 19). About two-thirds of those certified forests are certified to standards endorsed by PEFC (about 258 million ha), which has become the world's largest umbrella organization for industry certification programs and includes the Sustainable Forestry Initiative (SFI) in the US and the Canadian Standards Association (CSA). In comparison, the FSC has about a third of the certified wood market, or 181 ha (FAO/UNECE, 2013, p.19). Together, these four programs certify almost 94 percent of the world's certified forests, but regional distribution between programs is highly uneven (Brack, 2014). For example, in Sweden, the FSC has certified the majority of forests, whereas in North America the SFI program covers 82 percent of certified forests.

Industry-led initiatives proliferated after the founding of the FSC, between 1995-2002. Both industry programs and the FSC sought support from the same relevant stakeholders, including forest land owners, timber companies, retailers, governments, and social and environmental movement organizations. Both industry programs and the FSC had the built-in support of core constituents (Cashore et al., 2004), whose interests determine their requirements for legitimacy as a political body governing the practice of sustainable forest management. For forest landowners and timber companies supporting industry certification as an alternative to the burdensome requirements of the FSC, legitimacy required efficiency. By contrast, the FSC emerged from a partnership between WARP and major ENGOs and more radical environmental and social movement organizations interested in a constructive alternative to the anti-timber campaigns and consumer boycotts. For these groups, the political legitimacy of the FSC was its inclusive multi-stakeholder association, involving NGOs, corporations, academia, social-movements, community-based organizations, governmental agencies, academic researchers, philanthropic foundations and even the World Bank (Bartley, 2007a) engaged in transparent, deliberative democratic decision-making.

However, for both, their ability to win market share in forest certification depended on the procurement policies of upstream supply chain actors. Governments and wood retailers like Home Depot in the US and B&Q in the UK were in a position to endorse forest certification generally or more specifically. Choosing one program over another confers legitimacy to certain rules of conduct or resources. For example, firms that sought certification under the SFI or PEFC helped legitimize these industry programs' value of logistical efficiency over the FSC's more

rigorous chain-of-custody tracking. Similarly, when governments explain their preference for FSC-style certification in their procurement policies as based on the participation of (and support from) environmental and social movement organizations, they helped legitimize the FSC's multi-stakeholder decision-making structure.

The FSC enjoyed strategic support from a handful of major retailers, largely a result of the ongoing efforts of WWF-International, FoE and other NGOs to form sustainable timber buyer-groups. With these major retailers already committed to implementing procurement policies based on FSC principles and criteria, the FSC was poised to be the certification program of choice for timber companies that depended on retailers like Home Depot and B&Q for market access. Industry associations attempted to undermine the FSC's advantageous relationship by publicly questioning the legality of retailers' purchasing policies (Cashore et al., 2004; Cashore et al., 2003). However, when this strategy failed, industry groups they lobbied retailers and governments to make their procurement policies neutral by using the broader language "third party independent certified products," as opposed to specifically naming the FSC (Cashore et al., 2003).

Industry, in turn, sought support from governments. As wood buyers, some governments listed the FSC in their purchasing policies, such as the United Kingdom's procurement office. However in these early years of competition, this was more an exception. The timber industry began a lobbying effort to convince governments not only to create sustainable timber procurement policies, but also to name the SFI or PEFC specifically. In the US, industry convinced as many as fifteen state legislatures to pass resolutions for public procurement of sustainable wood based on the SFI program (Cashore et al., 2004).

FSC supporters responded by demonstrating that industry programs had weaker standards that amounted to industry self-regulation. They attacked the credibility of industry-sponsored certification programs, asserting that industry certification amounted to positive public relations without advancing sustainable management practices in timber-based supply chains (Cashore et al., 2004; Overdevest, 2005). For instance, the SFI program did not track wood through the chain of custody from forest land to wood retailer. Nor did it make available company specific data to the public. SFI members could also audit themselves, instead of using more costly third-party auditors. Furthermore, industry programs lacked multi-level governance structures, multi-stakeholder consultations, regular revisions to performance-based principles and assessment criteria. In essence, FSC-supporters used benchmarking and strategic public comparisons to show important supply chain actors, such as Home Depot and the UK government, that there were significant differences between industry certification and the FSC. Overdevest (2010) argues that this process of benchmarking and public comparison were key mechanisms through which FSC-supporters were able to establish themselves as a legitimacy-providing community. Convinced of the evidence showing industry programs to be weak, image-conscious retailers like Home Depot and Lowes released procurement policies specifying a preference for "FSC-style" certification. The FSC also received less direct endorsement at the international level in 1998, when the World Bank announced a partnership with WWF-International to certify 200 million hectares of forest area under principles and criteria identical to those of the FSC (McNichol, 2002).

With retailers re-affirming their support for FSC-style certification, industry programs adopted a number of FSC features. To address criticism that the SFI lack a chain-of-custody tracking system, SFI developed a partnership with the American Tree Farm System—a volunteer group of professional foresters that agreed to carry out on-the-ground assessments of foresters' management practices (Cashore et al., 2004). PEFC also introduced more stringent third-party auditing standards, such as regular audits of participating forest owners. To compensate for the lack of international coordination, industry programs institutionalized multi-level relationships between regional initiatives. The PEFC became a de facto umbrella organization for national initiatives in Europe. The SFI and CSA soon joined its European counterparts by applying for inclusion in the PEFC as an attempt to align their standards and advance international harmonization of industry programs, similar to the multi-level governance structures of the FSC. The SFI also created the International Forest Industry Roundtable to foster international harmonization. To address the imbalance in representation of ecological, social and economic interests, industry programs implemented participation mechanisms for environmental groups (Cashore et al., 2004). For example, the SFI spawned the Sustainable Forestry Board (SFB) as an independent group to oversee its the revisions to standards and other certification rules. SFB recruited NGOs, such as the Nature Conservancy and Conservation International, and forest protection activists, such as the Yale School of Forestry and Environmental Studies' Dean Gus Speth, to its board with little backlash from industry groups (Cashore et al., 2004). Furthermore, the industry attempted to improve its transparency and accountability mechanisms by implementing third-party auditing and increasing publicly available information (Overdevest, 2005).

FSC supporters also responded to some industry critiques. A number of initiatives emerged to address complaints about the high costs of certification. To reduce costs for small land owners, one US initiative proposed a process to streamline certification for landowners that meet "low risk" criteria. Another initiative by the FSC-accredited auditor SmartWood proposed an umbrella certification, whereby multiple groups could obtain certification through the same application. However, because these changes were proposed by FSC accredited certifiers rather than official FSC decision-making bodies, change has been slow. National-level FSC bodies have lacked the capacity to implement changes quickly due to the time-intensive requirements of multi-stakeholder decision-making (Cashore et al., 2004).

The FSC as a normative authority in the organization field of forest certification

Examining the proliferation of forest certification programs through the lens of organizational field theory is useful for understanding how the FSC has evolved alongside competition from industry certification programs like the SFI and the CSA through the process of "structuration" (DiMaggio and Powell, 1991). Bartley (2007) argues that understanding forest certification as an organizational field allows for a richer analysis of the process by which forest certification emerged.[149] In this subsection, use organizational field theory's concept of structural

[149] Bartley (2007a) highlights the role that foundations and social movements play as "field builders." Foundations coordinated grant making for the FSC during its inception, distributing funds strategically to ensure participation from environmental and social movement organizations. Foundations also helped enroll key actors into the project of establishing the FSC as a market-based alternative to boycotts. Having these groups' buy-in helped secure the FSC's development as a transnational regulatory regime as opposed to an industry self-regulatory regime.

to explore why industry certification programs have, over time, become more like the FSC in certain ways.

Broadly, and "organization field" refers to a functionally specific arena in which a set of similar and dissimilar interdependent organizations operate in a functionally specific arena, are similarly defined in terms of strategies and institutional structure, and work with similar partners, funders, and/or regulators (Scott, 2004, p. 9). Organizational fields include the network relations among actors and organizations operating in the same functional arena, as well as the cognitive resources that provide frames that give form to shared meaning. It is this intersection of networks and frame (or, intersection of inter-organizational relationships and shared meanings) that constitutes an organizational field (Bartley, 2007, p. 233). Analyses of organizational fields explain particular collective problem-solving projects, focusing the emergence of institutional responses (origin) and subsequent organizational development (structuration) in response to particular constructions of a social problem.

DiMaggio and Powell (1991) argue that organizational fields undergo structuration—a process characterized by the tendency towards institutional isomorphism. Structuration is essentially a process theory for understanding how entities within a field co-evolve by developing shared identities, meanings and standards of conduct (Barley and Tolbert, 1997). Structuration helps explain how legitimacy is achieved within an organizational field when a process of "coercive isomorphism" drives the institutionalization of norms and authoritative relationships. The construction of shared meanings legitimates the identities of entities in an organizational field and helps to reinforce their capabilities. Organizational field entities produce and re-produce shared meanings and practices in order to maintain their internal approach to collective problem solving. Amid constant external changes, the reproduction of meaning provides legitimacy.[150] In addition, patterns of domination and coalition building emerge between organizations in the field, solidifying certain organizations as having more or less legitimacy than others (DiMaggio and Powell 1983: 148).[151] Legitimacy can rest on a number of requirements, like democratic decision-making, the ability to provide social or economic stability, the capacity to solve problems, or efficiency.

By the end of the 1990s, the FSC appeared to have won the competition for legitimacy. Industry programs had done more conforming to FSC-style certification than convincing the FSC to change (Cashore et al., 2004). The SFI, CSA, and PEFC had "ratcheted up" their rules and structure by adopting FSC-like innovations. Third-party auditing, chain of custody tracking, public reporting, multi-stakeholder consultation, and multi-level governance are now common features in industry-led programs (Cashore et al., 2004; Cashore et al., 2007; Overdevest, 2005). The FSC and its competitors have moved closer together, evolving into a more cohesive arena of forest governance (Meidinger et al., 2003; Overdevest, 2010). Despite ongoing competition for

[150] For example in his study of the organizational field of art museums in the US from 1920-1940, DiMaggio (1991) show how art museums developed shared structures when subjected to external pressure to demonstrate legitimacy. Similarly, Frumkin (2008) shows how entities within the field of philanthropic foundations engage in a complex game of "peek-a-boo" as a strategy for appropriating ideas and practices from other organizations that appear to more legitimate or effective.

[151] According to DiMaggio and Powell (DiMaggio and Powell, 1991, p. 67) a field undergoes "coercive isomorphism" when pressured by societal interests (e.g. environmental groups, the media) or government regulatory developments that challenge legitimacy in the field legitimacy.

the same market actors, supporters of different regimes have come to some agreement about how the rules and resources of the field should be structured—the rules being what constitutes legitimate conduct from a normative perspective, and resources being the material power that enable some field actors to exercise authority or domination. Competing certification regimes initiated by industry actors who chose not to participate in the FSC have innovated to become more like the FSC. Industry groups now share the norms of inclusivity, accountability, and transparency. Even though the FSC and its industry competitors do not practice these norms in the same way, structuration has "raised all boats."

NGO and social movement activists within the FSC's core constituency were able to assert the FSC's normative authority by shifting the "field frames" for legitimacy. Field frames are "political constructions" that give order and meaning to organizational fields by creating norms that deem some practices to be more appropriate than others (Lounsbury et al., 2003, 76-77). Through the FSC's external monitoring and public benchmarking, FSC supporters could point to the performance weaknesses of industry standards (Overdevest 2010). They also made democratic decision-making the ultimate standard for evaluating legitimacy.[152]

Other supply chain actors reinforced these frames, namely retailers and governments with sustainable wood purchasing policies. International bodies like the World Bank and FAO also endorsed the FSC over industry certification programs. For example, the World Bank requires that the forestry projects it finances be monitored through independent assessment and certification (McNichol, 2002). In 1998, the World Bank announced a partnership with WWF-International to certify 200 million hectares of forest area under principles and criteria identical to those of the FSC and now requires that all forestry projects financed by the World Bank be monitored through independent assessment and certification (McNichol, 2002).

In effect, the FSC assembled a coalition of supporters that endorsed its position as a source of normative authority in the organizational field. By contrast, such a coalition did not validate the industry groups' efforts to frame the field by defining the legitimacy of a forest certification program in terms of the sufficient incorporation of industry input, logistical efficiency, and administrative ease. In order to avoid being reduced to industry self-regulation, industry certification programs increasingly accepted the FSC supporters' field frame of legitimacy as inclusive representation in democratic decision-making, accountability, and transparency. For example, these regimes innovated to involve other stakeholders who are impacted by their business in their rule making (Pattberg, 2005).

That FSC competitors adopted core FSC features indicates broad consent to the FSC's exercise of normative authority. The words of a participant in the formation of the FSC illustrates the role the FSC plays in the field of forest certification:

[152] As Bernstein (2012, p.147) explains, "Democracy has emerged as the answer to the legitimacy problem because it is the central principle in contemporary politics that justifies authority." As Bernstein explains, legitimacy justifies authority in a governance regime (Bernstein, 2012). Bernstein (2012, p. 148) defines legitimacy as a source for justifying authority that flows from a community consenting to rule making and the exercise of authority. When a particular mode of legitimation becomes institutionalized in a regime is historically contingent on a society's values, goals, and practices.

> The rapid emergence over the past years of independent third-party forest certification programs, and of the Forest Stewardship Council (FSC), has changed the nature of the entire international forest policy debate… In practical terms, it can be said that the FSC is writing the world's definition of sustainable forest management. While it is true that other organizations are writing theirs as well, the FSC is clearly setting the pace at the international level… I am absolutely convinced that few other entities have changed the political debate over the world's forests—for the better—as much as the FSC. (Viana et al., 1996, p.185-87)

If preferences for "FSC style certification" persist in retailer and government purchasing policies, and if the FSC keeps credible NGOs and social movement organizations involved in their rule-making process, it is likely to maintain an authoritative position over key field frames in forest certification. When the FSC General Assembly revises standards at the international level, these changes will trickle down through national and regional FSC bodies. It follows that industry certification programs will follow suit to quell criticism from environmental and social groups that challenge their legitimacy.

However, maintaining its normative authority depends on a number of assumptions. For one, the field would have to maintain a shared norm for transparency and accountability so that the practice of external monitoring and public comparison can continue as a strategy for pressuring industry to adopt FSC innovations in order to maintain legitimacy. Second, whether industry responds to such pressure will depend importantly on whether governments and retailers continue to sympathize with these criticisms. A third assumption is that competition to certify more forests continues such that the FSC and industry programs keep ratcheting-up their standards.

The weaknesses of forest certification governance

Despite industry's innovations, industry laggards in the field of forest certification persist, hindering the potential for implementing sustainable forest management practices. To date, no industry programs match the rigor of the FSC. FSC-style innovations in industry programs have filtered out key elements of the FSC model. For example, on the issue of balanced representation in multi-stakeholder decision-making, industry certification programs give greater representation to economic interests over environmental and social interests. The Sustainable Forestry Board may have opened its board to non-industry stakeholders, but the proportion of board seats reserved for industry officials allows for greater industry representation relative to the FSC's three chamber, open membership structure (Cashore et al., 2004). Consequently, relatively weak industry certification programs persist, enabling laggards (namely large forest industry companies and small forest landowners) to continue to operate with minimal changes to their practices (Gulbrandsen, 2008).

A major critique of forest certification has been its poor penetration in less developed economies. The majority of certified forests are located in North America and Europe. In developing countries, certification has been more limited (Humphreys, 2006, #50632). As discussed earlier in this section, the FSC's targeted medium and large industrial forest companies in developed economies as early adopters of forest certification because they represented the majority of the global wood market. Brazil, Malaysia and China all possess significant areas of certified forest, but overall, certification in the developing world is low: in 2010, only 2 percent of tropical forests were certified (Brack, 2014, p. 51). By 2014, PEFC had expanded coverage

substantially in China, and the FSC increased percent of certified forest cover in tropical or sub-tropical areas to 20 percent (Brack, 2014). Absent customers who are willing to pay price premiums for sustainable wood products, landowners and timber companies in developing countries may have little incentive to take on the costs of certification. Yet, even in developed countries, it is not clear that timber producers have the incentive of an economic value-add from certification. Cashore et al. (Cashore et al., 2004) argue that selling certified wood into supply chains where end consumers are willing to pay a price premium does not reliably offset the costs of certification for land owners, timber operators and wood products producers (Cashore et al., 2004).

Despite its shortcomings, FSC-style regimes have become a popular institutional response to GEG problems. In other sectors, similar regimes have been modeled after the FSC, for example in mining, tourism, coffee, fisheries, food production, and most recently, biofuels (Cashore, 2002; Pattberg, 2005; Bartley, 2007). As with the FSC, the centerpiece of these regimes are inclusive multi-stakeholder decision-making processes, transparency and accountability. Managerial elite from transnational NGOs lead these initiatives by organizing roundtables to identify global principles, then by codifying global principles into performance standards and establishing procedures for rule-making and operations. FSC-style regimes have also expanded beyond the boundaries of what is considered private transnational regulation. In the forest case, many public procurement programs are based on private forest certification programs (Brack, 2014). Governments have also turned to private certification in the absence of public regulatory frameworks. For example, the Bolivian government recognizes forest certification as equivalent to government inspection for the purposes of granting timber concessions. Gulbrandsen (2014) points out that the increased interaction between states and non-state actors in both the forestry and fishery sectors has resulted in the strengthening of FSC-style certification as an institutional response.

As the next Section 6.4 shows, the interaction between states and non-state actors in global forest governance has evolved further, blurring the lines between public and private regulatory regimes. To better address the problems of illegal timber, governments have developed parallel public regimes that mimic structures in the private forest certification field. Like private transnational regulation, these regimes work transnationally through the marketplace and resemble FSC-style certification in many ways. However, unlike private transnational regulation, they draw upon public authority explicitly. Multiple government-led regimes now exist to address illegal logging, but these regimes do not constitute an organizational field in which entities compete for legitimacy to win market-share. Rather, these government-led regimes operate from particular political jurisdictions as public transnational regulation.

6.4 Public Regimes for Forest Governance: Legality verification in the timber trade

Although the field of sustainable forest certification grew throughout the 1990s, so too did worldwide deforestation. Global deforestation rates continued at levels roughly comparable to the 1980s (FAO, 2001). Voluntary certification initiatives had little impact in curbing illegal logging in tropical forests of developing countries, one of the principal causes of global deforestation and climate change (Bernstein and Cashore, 2012, p. 602; Tanczos, 2011). Tropical

forests account for less than 5 percent of sustainably certified forests (Bernstein and Cashore, 2012), and among those tropical forests with certification, standards of legality can be too simply defined and/or poorly verified. For example, the FSC and the PEFC—the two largest certification schemes—had legal timber harvesting requirement based on whether a timber operator had 'the right to harvest' or had complied with national laws. Moreover, to claim that a solid wood product is certified, the FSC and PEFC originally required that only 70 percent of the wood product come from certified wood--a standard that was eventually tightened to 95 percent--thereby allowing a small percentage of potentially illegally sourced timber into certified wood product supply chains.

Environmental NGOs (ENGOs) and activists pressured governments to take action to stop illegally-sourced timber from entering global supply chains for wood fiber products. At this point, many governments in Europe, Canada, the US, Japan and New Zealand regulated legality through their sustainable timber procurement policies, which were largely based on either the FSC and PEFC. ENGOs advocated government-led creation of "a robust international mechanism for establishing certification of legality with independent verification" (FOE, 2002, p.10). Beginning in the late 1990s, a series of international and domestic initiatives emerged to address the illegal timber trade. In 1998, the G8 Illegal Logging Action Programme on Forests generated a number of state responses to the illegal logging and trade. As leader of G8 initiative, the UK Department of International Development invested in numerous studies and discussions, including assessments of the state of illegal timber production and trade and the effectiveness of existing measures to control it. Soon after these activities, the G8 funded a series of regional dialogues on Forest Law Enforcement and Governance (FLEG) in 2001 led by the World Bank (Brack, 2005). Regional FLEG dialogues focused on building greater capacity for enforcing existing laws, reducing contradictions between legal regimes, enlisting NGOs to monitor activities on-the-ground, and using labels to distinguish legal timber throughout the supply chain (Bernstein and Cashore, 2012, p. 596-7).

The World Bank FLEG initiative resulted in a set of guidelines that encouraged timber-consuming and timber-producing countries to forge bilateral agreements on illegal timber production and trade without violating WTO rules. Under WTO rules, a large jurisdiction such as the EU or the US may unilaterally seek to extend its internal regulations to transnational supply chains as a condition of market access. WTO member states can restrict imports in order to protect public health and the environment. However, as interpreted by the WTO Appellate Body in its landmark Shrimp-Turtle decisions (WTO 1998, 2001), any resulting barriers to trade on these grounds must be non-discriminatory and proportional to the intended goals of managing public health or environmental risks. In practice, member states must take into account relevant international standards when designing regulation and consult with their trading partners to minimize the impact on affected third parties (Weinstein & Charnovitz 2001; Scott 2007).

As detailed in the next sub-section, between 2003 and 2013, a series of regulatory developments in the EU and US have emerged to reduce illegal logging in domestic supply chains. These developments reflect the guidelines developed by the World Bank Regional FLEG dialogues, which advise building greater capacity for enforcing existing laws, reducing contradictions between legal regimes, enlisting NGOs to monitor activities on-the-ground, and using labels to distinguish legal timber throughout the supply chain (Bernstein & Cashore, 2021:

596-7). Yet rather than pursue bilateral trade agreements, governments have developed a kind of public transnational regulation to verify the legality of timber entering the EU and US markets. Like private transnational regulation, these public regimes work transnationally through the marketplace. However, as public regimes they are subject to political forces within particular jurisdictions, including domestic institutions and commitments to international trade law.

The 2003 EU Forest Law Enforcement Governance and Trade (FLEGT) Action Plan

To implement the World Bank FLEG guidelines, the EU developed a Forest Law Enforcement Governance and Trade (FLEGT) Action Plan in 2003. FLEGT constituted a multi-level timber licensing system designed to allocate timber export permits based on the legality of timber production. The center piece of the EU FLEGT Action Plan is the formation of a bilateral agreement between the EU and timber exporting countries known as a "voluntary partnership agreement" (VPAs). Under a FLEGT VPA, partner wood-exporting countries—predominantly in Africa and South-East Asia—agree to establish a national export licensing systems for legality verification. EU member states and the EC commit financial and organizational support to help partner countries implement the licensing system. Each VPA is overseen by a joint committee of EU and partner country representatives. The joint committee is responsible for dispute resolution, overseeing implementation of the VPA, assessing its social, economic, and environmental impacts, recommending necessary changes.

All FLEGT VPAs required a multi-stakeholder process be used to develop jointly-defined legal standards for "legally harvested timber." Parties to a VPA must conduct multi-stakeholder reviews of domestic laws and international treaty commitments[153] dealing with fiscal, forestry, environmental, labor protection, worker health and safety, and indigenous rights issues (Brack, 2005). Where weaknesses in existing domestic law are evident, or if there are conflicts between different kinds of laws, local decision-makers commit to making legal and administrative reforms. This process aims to ensure FLEGT export licensing systems are fit the unique national contexts and domestic regulatory styles of developing country VPA partners. If wood meets the standards of the national export licensing system, the producer country can issue a FLEGT export license to a timber exporter, whose wood product may then travel through the chain of custody, accumulating documentation of timber origin, land ownership, harvesting and processing.

Although each individual VPA is unique, they all aim to meet the same international norms for managing illegal harvesting. For example, VPAs generally encourage partner countries to develop kinds of chain-of-custody tracking systems, similar to those first developed by the FSC. They must incorporate regular monitoring, performance reviews and third-party verification of control over the flow of logs from the forest to the point of export. Similar to private certification, FLEGT partner countries issue licenses to timber operators, who must provide proof of legality that meets the definitions set out by the VPA.

153 For example, since 1975 implementation of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) has aimed to ensure that international trade in plants and animals does not threaten their survival in the wild. Currently 180 parties including the United States have implement CITES.

The FLEGT Action Plan had a number of shortcomings that undermined its efficacy. First, VPAs could take years to negotiate, given the requirement for deliberative multi-stakeholder processes to define legality standards (Overdevest and Zeitlin, 2012). Second, a FLEGT licensing system could amount to little more than a "paper tiger" that produced the unintended consequence of increasing timber harvesting that is technically legal but unsustainable (Bernstein and Cashore, 2012: 602). Third, FLEGT licensing systems did little to stop illegal timber exports from entering the EU market. Because of the voluntary nature of FLEGT Action Plan, wood from countries without VPAs could still access the EU market. Illegal timber from a partner country could be "laundered" through non-partner countries. Given this uneven playing field, many potential partner countries were reluctant to move past VPA exploratory talks to implement a FLEGT licensing system (Overdevest and Zeitlin, 2012).

As it became clear the FLEGT Action Plan alone could not eliminate illegal timber from the European market, new proposals emerged for EU-wide legislation (Brack, 2005). ENGOs involved in the debate advocated designing legislation similar to the US Lacey Act—a 100-year-old law originally designed to combat wildlife trafficking. As the idea to use the framework of the Lacey Act to combat timber trafficking gained support in the European Parliament (Brack, 2005: 35), international ENGOs like Greenpeace and the UK-based Environmental Investigation Agency (EIA) pushed US policymakers to amend the Lacey Act (Tanczos 2011).

The 2008 United States Lacey Act Amendments

The ENGO proposal to amend the US Lacey Act would expand the law to include the prohibition of all illegal plant products, including trees and wood products (e.g. paper, furniture, lumber, flooring) stolen or logged without proper legal authorization in other countries. The proposal garnered key support from domestic wood producers, who saw the Lacey Act as a way impose costly environmental standards on foreign competitors (Tanczos 2011).

In 2008, Congress amended the Lacey Act, making the US the first country to ban illegally sourced timber. Under the amended act, it is illegal to import, export, transport, sell, receive, acquire or purchase any plant or plant product taken in violation of federal, state or relevant foreign laws. To comply US-based importers, exporters and traders of wood products must submit documentation that verifies "due care" has been taken to minimize any risks of illegal timber from entering US supply chains. This 'fact-based' rather than 'document-based' statutory approach holds companies liable if their certification documents turned out to be inaccurate—for example if wood once thought to be legal turns out to be illegal unbeknownst to the certifier. Thus, each company is responsible for ensuring that a Lacey violation has not occurred at any point in their supply chain, all the way back to the forest of origin.

However, the amendments did not go so far as to specify clear criteria for demonstrating "due care." Many industry actors expected private forest sustainability certification would be an acceptable strategy for complying with the Lacey Act (Goetzl and Ekström 2007). The FSC and other private sustainable forest certification programs claimed their programs could ensure Lacey Act compliance. In the absence of clear regulatory guidelines, many US firms looking toward private certification as a strategy for complying with the Lacey Act in the absence of clear

regulatory guidelines McClanahan, 2010.[154] Yet the assumption that private certification would satisfy public regulatory requirements was soon called into question. In 2009, the US Department of Justice seized FSC-certified wood products from the Gibson Guitar Corporation on suspicion that the company was using illegally trafficked wood. The Gibson Guitar Corporation—a longtime supporter of the FSC—settled with the government in 2012 for a $300,000 fine.

Rather than issue a regulatory implementation guideline, the US government gave industry the leeway to determine their own compliance strategies. One explanation has been that the DOJ preferred not to define "due care" in order to avoid limiting its prosecutorial discretion (CMP, 2011). Specifically the US Department of Justice and US Department of Agriculture gave recommended that the private-sector design a "consensus standard" to demonstrate "due care." Due care standards have been negotiated for other US regulations such as for purposes of superfund environmental cleanups. In 2011, the Lacey Act Defense National Consensus Committee began crafting a voluntary consensus standard, composed of relevant US stakeholder groups, from a range of economic, ecological and social interests, including the FSC, a variety of NGOs, law firms, companies and industry associations.[155] In order to produce consensus, Capital Markets Partnership (CMP)—a subsidiary of Market Transformation to Sustainability (MTS), a voluntary consensus standards developer accredited by the American National Standards Institute (ANSI)—lead the collaboration, involving business representatives affect by the Lacey Act as well as prominent environmental groups like the Rainforest Alliance, the National Wildlife Federation, and the FSC.

By 2012, the committee released the "Lacey Due Care and Innocent Owner Standard" (Laceycare.com, 2012). The standard is a legal opinion that outlines procedures that companies can take to show that their wood and paper products are lawfully possessed. The primary objective of the standard is to help companies during legal adjudication. By obtaining Certification of Compliance with the "Lacey Due Care and Innocent Owner Standard," a company being investigated or prosecuted by the DOJ can assert "Innocent Owner Liability Defenses" (relevant legislative, statutory, and case law history) in the appropriate US District Court.

To help companies avoid violations, the standard requires that applicants to obtain forest certification under the FSC, PEFC, or the Seneca Creek / AHEC US Hardwood Program. for possessing illegally trafficked or logged wood products. While certification like the FSC can be a part of a company's "due care," alone it is not a guaranteed defense against Lacey Act prosecutions. Under the Lacey Act, any wood-importing company has responsibility for its

[154] WWF's Global Forest Trade Network has also reported a spike in interest in certification. Smartwood - a certification system run by the Rainforest Alliance, an environmental group - claims to have registered "a significant increase in interest in verification services since the Lacey Act was passed," including requests from Paraguay, Guyana, China and Russia - countries in which it had never worked in the past.

[155] Organizations that joined the Lacey Act Defense National Consensus Committee include the Forest Stewardship Council, Anderson Berkshire Hathaway, National Wood Flooring Association, Rainforest Alliance, Knoll, Williams Sonoma, Sustainable Furnishings Council, National Wildlife Federation, Floor Covering Institute, Wood Flooring International, Gibson Guitar Corporation, Staples, Home Depot, Kimberly-Clark, Columbia Forest Products, C.F. Martin & Company, Danzer Group, the Capital Markets Partnership, and a number of industry associations such as the National Association of Music Merchants (NAMM).

supply chain partners. This means that regardless of FSC-certification, a company must ensure that any exporting company it receives wood and paper products from has the right to export that product according to the laws of the country of origin.

The 2010 European Union Timber Regulation (EUTR)

In 2010, following the US example, the European Parliament passed the EU Timber Regulation (EUTR). The EUTR requires timber "operators" (companies that first place timber or wood products on the market in the EU) to assess the risk of illegal sources. If, after conducting a risk assessment, the risk of illegality is considered not to be negligible, an operator must mitigate the risk by taking additional measures to verify legality. To comply with the EUTR, operators must have some kind of due diligence system in place. The law stipulates three categories of acceptable due diligence systems: a FLEGT license, a CITES[156] license, or a private due diligence system that meets EUTR criteria for obtaining proof of legality.

Without a FLEGT or CITIES license, timber operators must implement their own due diligence system—a potentially burdensome undertaking. First, operators must obtain a range of verifiable information through their due diligence procedure, including descriptions of the product, the timber species used, the country of harvest, the quantity, names and addresses of suppliers and traders, and documents showing suppliers and traders have complied with all applicable legislation. Second, operators must conduct risk assessment. Using the information collected from the first step, operators must assess the risk that illegal timber has been handled in their supply chain. Criteria for assessing risk include considering the prevalence of harvesting specific tree species in the supply chain involved, the prevalence of illegal logging in the country of harvest, the complexity of the supply chain, the assurance of compliance with applicable legislation and private certification programs, and whether there are any United Nations or EU sanctions applicable to these supply chains. If the risk is not 'negligible[157],' mitigation measures are required. This means the operator must either go through additional lengths to verify its product or remove its product from the EU market.

In effect, the EUTR gives operators with products covered by a FLEGT Voluntary Partnership Agreement or by CITES (Convention on International Trade in Endangered Species) access to a "green lane," a kind of fast track into the EU market. CITES certificates can also be used as legality verification for the four commercial tree species currently listed, which may serve to reinforce the credibility of CITIES licenses. FLEGT VPAs are promoted as the ideal way pathway for developing legality verification institutions in timber producing countries. Although no licensed FLEGT VPA material was available at the time the EUTR was implemented, it is expected that operators with these exemptions could have a competitive edge over those who cannot access this green lane into the EU market.

[156] CITES permits are required for wood species listed in the Appendices of the Convention on International Trade of Endangered Species (CITES), an international agreement between governments formed in 1973 to protect endangered species. See European Commission (2013).

Private certification is positioned to bridge the gap between any operators with and without the green lane exemptions. In drafting the EUTR, the European Parliament initially considered officially recognizing voluntary forest certification schemes like the FSC as "due diligence systems" on par with a FLEGT or CITES license. Ultimately, the EP decided against allowing private certification programs like the FSC, PEFC or SFI the same access to the EUTR "green lane." However, the EUTR implementation regulation accepts private certification schemes as the risk assessment component for the EUTR due diligence[158] system if they meet three requirements: regular field visits once very twelve months by an independent third party; third party verified tracing of legally harvested timber products throughout the supply chain; and third party verified controls to ensure only legal timber with known origin enters the supply chain.

6.5 Forest governance as an experimentalist regime complex

Since the 1992 Earth Summit and the 1994 General Agreement on Tariffs and Trade (GATT), there has been a proliferation of public and private regimes that exert rule-based influence over the production and consumption of timber. Together, they comprise a forest governance regime complex that considers deforestation to be a global governance problem worthy of collective action and aims to change behavior in timber-based supply chains. In this concluding section, I discuss forest governance as regime complex with experimentalist architecture.

Architecturally, this regime complex has two weakly nested sets of experimentalist regimes with overlapping rules. As discussed in Section 6.3 above, private forest certification regimes have been weakly nested under the normative authority of the FSC. Industry-led certification programs have adopted many of the values and organizational structure of the FSC' in response to pressure from FSC-supporters, namely activist organizations, wood retailers and government purchasing offices. These private regimes exhibit similar experimentalist structures and function autonomously without any formal centralized authority. However, a broad coalition recognizes the FSC as having greater legitimacy than industry-led programs, thereby endorsing its normative authority over other forest certification programs. Thus, in the field of private certification indicates, competition between regimes did not signify an all out race-to-the bottom.

The FSC has also proven to be an influential model for public legality verification regimes. For example, public regimes have adopted a similar model of multi-stakeholder inclusion in rule making. The FLEGT and EU Timber Regulation internalized many lessons from the FSC (Overdevest and Zeitlin, 2012, p. 25). This led to a deliberate effort to formalize an experimentalist system to support shared goal-setting, comparative assessment, cross-fertilization, and upward harmonization (Overdevest and Zeitlin, 2012, p. 9). The FLEGT Voluntary Partnership Agreements (VPAs) require deliberative multi-stakeholder processes to define legality standards, as does the "consensus standard" developed for the US Lacey Act. Like private certification programs, national FLEGT VPAs undergo a process of monitoring and benchmarking. Every five years, VPAs must review the progress of their partner country's

158 Important clarifications on the use of certification were provided in the EUTR Implementing Regulation 607 released by EU July 6, 2012. Additional EU guidance documents were released in September 2013, the year the regulation came into force.

FLEGT licensing system and makes necessary revisions to definitions and operations. In addition, the chain-of-custody systems piloted in the field of private forest certification have provided a model for public regimes (Auld et al., 2010). The FLEGT, EUTR, and the US Lacey Act all endorse a chain of custody verification process that enables firms to pass on assurance of legality to their supply chain partners, the same way in which private forest certification passes on assurance of sustainability.

In addition, the EUTR and US Lacey Act regulations have integrated private forest certification directly into their compliance standards' guidelines. Neither the US nor the EU went so far as to write voluntary private certification schemes into the letter of the law; in order to avoid the risk of violating WTO agreements, states have refrained from implementing standards or requiring compliance with private standard programs (Bernstein and Cashore, 2007).[159] However, they have each interwoven private certification into their statutory fabric under their implementation guidelines. In the US, the consensus standard, the Lacey Act Due Diligence Standard, requires private certification programs like the FSC, representatives of which participated in the development of the consensus standard. In the EU, private certification schemes are now accepted as risk assessment processes, arguably the centerpiece of EUTR-compliant due diligence system.

Public regimes have also proved influential to private regimes, indirectly pressuring private forest certification programs to tighten their definitions of legality (Gulbrandsen 2014, p. 84). Forest certification programs initially failed to cover the full scope of regulatory definitions for "legality" in the Lacey Act and EUTR. Public definitions of illegal timber were more stringent and expansive than the FSC's, covering any timber harvested or transported in violation of national laws or regulation in the source country, including compliance with laws and regulations for trade and customs regulations, health and safety, environmental stewardship, and third party rights to harvesting. Forest certification programs revised their definitions and standards for sustainable forest management to align with the Lacey Act and the EUTR. For example, the FSC General Assembly and major industry certification programs responded to the World Bank G8 initiative by modifying their legality standards. In 2011, the FSC General Assembly unanimously approved a motion to strengthen its Controlled Wood standards by the end of 2012 in order to bring it in line with the EUTR and the US Lacey Act. The FSC phased out its original allowance of up to 5% of FSC certified material from unknown sources to require that all certified wood be traced to a known source. In March 2013, FSC also introduced a new rule that obliges chain of custody certificate holders to have a system that ensures FSC certified products comply with all applicable trade and custom laws. The PEFC has made similar changes. Thus, to some extent, the FSC is weakly nested under public regimes by virtue of its WTO-compatibility and responsiveness to dynamic public regimes as a participatory, deliberative decision-making (Meidinger, 2010; Overdevest and Zeitlin, 2012; Gulbrandsen, 2014).

[159] The basic trade principle of nondiscrimination under the GATT, encapsulated in the most favored nation and national treatment rules, oblige parties to treat all imports from another GATT party no less favorably than they treat any imports from any other party while also treating all imported products no less favorably than "like products" that are produced domestically. Under Article XX of the GATT, any environmental restriction (e.g. bans, quotas, labeling requirements) that discriminates against the imports of a GATT party vis-à-vis another GATT party violates the principle of nondiscrimination, unless the environmental restriction is "necessary to protect human, animal or plant life or health."

Architecturally, both sets of regimes share many of the same experimentalist features (Overdevest and Zeitlin, 2014). Like sustainable forest certification programs described in Section 6.3, FLEGT VPAs essentially diffuse experimentalism to smaller entities to carry out systematic benchmarking (Overdevest and Zeitlin, 2012). The experimentalist approach of the FLEGT VPA framework is premised on joint goal setting. The EU and its developing country partners collaborate to ensure the resulting national FLEGT licensing systems are appropriate to local contexts and in line with international standards. The partner countries implement legality verification definitions, laws and administrative processes. As the local entities in this experimentalist system, partner countries agree to use diagnostic monitoring so that the EU can track the progress of implementation. This, in turn, enables the parties to a FLEGT VPAs to identify problematic areas. It also enables the EU to evaluate VPAs to determine who laggards are. Because EU actors are the common denominator across all FLEGT VPAs, it is possible to organize peer review to drive cohesion across the different policy domains involved in FLEGT VGPAs. The FLEGT VPAs are continuously revised in increments of five years as part of a recursive learning process. Overdevest and Zeitlin (2012, p. 25) find that the FLEGT system's recursive learning platform has facilitated a "partial convergence" of policy preferences in the FLEGT VPA system.

Do experimentalist architectures enable greater coordination in the regime complex for forest governance? Overdevest and Zeitlin (2012, p. 2) argue, yes, in theory.[160] In the absence of a global forestry convention, an experimentalist learning platform can facilitate coordination between regimes, assuming all regimes have similar well-developed internal and external benchmarking capabilities, monitoring within each regime and between regimes, and peer review processes (Overdevest and Zeitlin, 2012). Well-developed experimentalist features throughout the regime complex would generate a kind of reflexive learning platform throughout the regime complex, which would increase each regime's capacity for "coordinated learning" (Overdevest and Zeitlin, 2012, p. 25). If such a recursive learning platform could extend more broadly to other parts of the forest governance regime complex, creating effective patchwork of transnational regimes engaged in coordinated learning that constitute a more comprehensive forest governance than any public or private regime alone.

Yet the coordinated learning envisioned by Overdevest and Zeitlin (2012) remains unrealized, given no other regime matches the well-developed experimentalist features of the FLEGT and the FSC. However, the FSC does not systematically pool monitoring results for system-wide analysis of where improvements are needed, nor does it systematically diagnose laggards within the broader regime complex to push certified entities to ratchet-up their performance. As Sabel (1994) argues, the FSC has not developed its capacity for learning by monitoring. This criticism extends to other components of the forest governance regime complex such as industry-led private certification regimes and the Lacey Act. The experimentalist regimes of the forest governance regime complex differ in their commitment to fulfill the broader goals of continuous learning.

[160] The authors are most concerned with contributing "a theoretically informed route to the stepwise construction of a joined-up transnational governance regime in a hotly contested policy field where no single actor can enforce a unilateral solution" (Overdevest and Zeitlin, 2012: 25).

Moreover, even a well-developed set of experimentalist features may not be sufficient to resolve conflict and rule inconsistencies between overlapping regimes in the regime complex. In other words, the EU FLEGT and the FSC may succeed at reducing conflicts and rule inconsistencies between the institutions that fall under their own nested purview (i.e. partner countries that have signed VPAs or national and regional FSC branches), but it is unclear that experimentalism alone would help resolve conflicts between the two regimes themselves. For example, in forest governance, public regimes regulating the illegal timber trade can clash unintentionally with the goals of sustainable forestry certification programs. Emerging definitions of illegal timber from FLEGT Voluntary Partnership Agreements (VPAs) may define legal timber harvesting in wood-exporting countries leniently, such that socially or ecologically unsustainable forest management practices go unabated.

Finally, the convergence among certification program described in 6.3 above points to the sources of normative authority can help drive convergence in a regime complex. For example, within the field of private certification, the standards of the FSC and the PEFC have become increasingly aligned (Gulbrandsen, 2014). FSC supporters worked to established the FSC as the gold standard for sustainable forest standards, and continue to pressure industry-led regimes to ratchet-up their standards and procedures accordingly. This is certainly facilitated by experimentalism. Yet the structuration analysis in 6.3 above suggests the politics of legitimacy is also an important mechanism for driving convergence.

This raises questions about where political authority lies in a regime complex; how the constituent parts of a regime complex establish shared, broad framework goals, and; what mechanisms lend themselves to resolving conflicts between regimes in the interest of cooperation. In the next chapters, I explore these questions in more detail using the case of biofuels governance.

Chapter 7 Scientific controversy in a coordinated regime complex for biofuels governance

In this chapter, I chart the emergence of a regime complex for biofuel sustainability. Early initiatives to construct global governance regimes for biofuels looked to forest governance as a model, most explicitly by fashioning the Roundtable on Sustainable Biofuels (RSB) in the mold of the Forest Stewardship Council (FSC). Examining the cases of forest governance and biofuel governance side-by-side also reinforces the claims developed in Chapter 6, namely that history of forest governance since the early 1990s suggests two overarching trends in global environmental governance: regime complex formation and experimentalist governance architectures. Biofuels governance exhibits both of these trends, as public and private regimes have emerged at multiple levels of governance—from transnational, supranational, national to sub-national levels—to ensure that the wave of renewable fuel targets established in Europe and North America do not prove to be socially or environmentally detrimental. These include state-led regulatory regimes developed by governments in Europe, the US and California. They also include regimes whose development was led by NGOs. As in the forest case, public and private regimes overlap to varying degrees.

Moreover, the case of biofuels governance suggests a new development in global environmental governance, what I call a "coordinated regime complex." Unlike regime complexes comprised of public and private regimes that emerge autonomously from each other, in competition (e.g. as a strategy of forum-shifting), or with overlapping jurisdictions, many of the policy actors involved in constructing individual biofuel regimes did so with the explicit intention of creating coordinating mechanisms between public and private regimes. Anticipating the proliferation of competing sustainability rules for the biofuels industry, a number of initiatives described below attempted to implement harmonization strategies that would to curb preempt the proliferation of competing sustainability standards. This finding supports O'Neill et al.'s (2013) overall observation that the dense and networked set of institutions involved in GEG "are starting to work much more as a collective whole."

Yet, despite efforts to build a coordinated regime complex for biofuels, achieving coordination within the biofuels regime complex has been undermined by scientific controversy. In particular, the question of how to calculate the low-carbon value of a given biofuel commodity chain divided policy actors across jurisdictions into those who believed emissions from indirect land use change (iLUC) to be a legitimate category for calculating the lifecycle emissions of biofuels compared to gasoline, and those who believed iLUC to be either too insignificant to matter or alternatively a Trojan horse deployed to undermine the industry's growth. Different policy jurisdictions pursued different approaches to addressing this issue. I primarily focus on the ways in which scientists and regulators in California and the US—and to a lesser extent the EU—approached the iLUC controversy. The main argument development here is that although coordination was not achieved in terms of establishing a harmonized approach to calculating the low-carbon value of biofuel commodity chains, scientific controversy itself legitimized the

concept of iLUC such that it is now considered a significant and legitimate factor worthy of inclusion in calculations for lifecycle GHG emissions.

Thus, this chapter draws our attention to the politics of expertise, and role of experts as source of normative authority in a regime complex setting. The implications of this for the larger field of global environmental governance are that those wishing to shape outcomes may need to not only look beyond multilateral negotiations and the regime complexes coordinated by coalitions of NGOs, governments, and international organizations, but also to the multiple spheres and levels across which experts can move more fluidly than other actors in regime complex.[161]

Section 7.1 reviews various concerns that emerged in response to biofuel consumption mandates in Europe and North America regarding the negative impacts of expanding the biofuels industry, which prompted transnational regulatory rules for sustainable biofuel production and trade. In Section 7.2, I examine the public regimes that emerged to address biofuels governance, looking closely at policy efforts in the Netherlands and the United Kingdom. These governments' parallel initiatives produced a set of influential sustainability principles and criteria, which constitute core pillars of the biofuel regime complex. Section 7.3 discusses private regimes that emerged in parallel with public regimes, focusing on the Roundtable for Sustainable Biofuels. Both of these sections discuss the proposal of a "meta-standard" as an experimentalist governance architecture that would help reduce the likelihood of rule inconsistencies between regimes as well as weak-standards resulting from the proliferation of competing industry-led standards.

In Section 7.4, I examine some of the conflicts that emerged within the biofuel regime complex regarding the definition of sustainability criteria and the thresholds for low-carbon value. Section 7.5 looks at the politics of expertise surrounding calculating lifecycle GHG emissions to obtain low-carbon values for particular biofuel chains. Here, I also discuss how carbon calculation methodologies have converged to some degree as the scientific controversy over iLUC has unfolded.

7.1 Public pressures for global biofuels governance

Between 2000 and 2006, global ethanol production doubled after a wave of government mandates designed to increase ethanol consumption in the EU, the US, Brazil, India and China (IEA, 2007). Ethanol production and trade continue to rises as part of the expanding global market for biofuels. By some estimates, a global biofuels market could provide 27% of total transport fuel used for automobiles and aircraft by 2050 (IEA, 2011). Although the initial public reception of biofuels was largely positive, public support began to turn in 2005 as new scientific reports and subsequently media coverage increasingly highlighted the negative effects of expanding biofuels production and consumption. Initially, much of the concern was focused on

[161] Here I am directly adapting Betsill and Corell's (pg. 204) recommendation that "NGOs wishing to shape environmental outcomes may need to look beyond multilateral negotiations and work in multiple spheres and tiers of governance simultaneously."

biofuels-related infrastructure developments, such as the impacts on cars, pipelines, railways, and shipping ports (Dufey and Grieg-Gran, 2006, p. 45).

By 2007, the "Food verses Fuel" debate had erupted amid a global economic recession. Responding to global food prices, critics of the biofuels industry pointed to the diversion of grain — namely corn — from food markets to ethanol markets as the principal driver of high food commodity prices and a threat to food security for the poor (see Naylor et al., 2007; Holt-Giménez, 2007). New research linked corn ethanol was linked to a rise in food prices worldwide, with estimates ranging from 25-75 percent (See e.g. Mitchell, 2008; FAO 2008). The corn-ethanol industry disputed the relationship between corn-ethanol production and food security by pointing to the number of complex factors that affect food prices, e.g. severe droughts, the increased demand for staple crops used as animal feed in emerging economies, the trading of futures in commodity markets, and governmental policies contribute to food price inflation (see Rosenthal, 2011). They also emphasized that corn-ethanol production contributes to global food supplies because animal feed is a key co-product in dry mill ethanol plants (Renewable Fuel Association, 2011). Despite a number of academic economists' skepticism regarding relationship between biofuels and rising food prices, pointing instead to the overall increase in commodity prices caused by unethical futures trading, the 'Food vs. Fuel' debate continued, supported by new research indicating biofuels cause dire impacts in food-importing countries (see Wise, 2012).

In addition, concerns emerged regarding the impacts of land use change. Converting rainforests, peatlands, savannas, or grasslands to produce more corn or sugarcane ethanol could harm biodiversity or sensitive ecological areas and release more CO2 into the atmosphere than would be saved by displacing fossil fuels with ethanol (Fargione et al., 2008; Searchinger et al., 2008). Lifecycle methodologies for quantifying biofuel greenhouse gas (GHG) emissions consider both direct and indirect land use changes. Yet, because these models rely on uncertain assumptions, policy justifications for expanding the ethanol industry rest precariously on the claim that ethanol can mitigate climate change through carbon reductions.

Moreover, expanding a highly consolidated industry dominated by powerful agri-businesses raised concerns about the equity and justice implications of global ethanol development, especially for less developed countries that were increasingly becoming the target of large agricultural processors (Hall et al. 2009; Dauvergne and Neville, 2010). The Brazilian industry had been criticized for major environmental impacts of large-scale monoculture agriculture; for poor living and working conditions among sugarcane plantation workers, with reports of human rights abuses; for social exclusion in ethanol industry development that has helped exacerbate the country's inequitable distribution of wealth (Martinelli and Filoso 2008; Hall et al., 2009; Fernandes et al., 2010; Dauvergne and Neville, 2010).

Under pressure to uphold the legitimacy of biofuel support policies, governments and industry actors tried to reassure publics that with new conversion processes, ethanol producers can convert a wider range of cellulosic material (e.g., corn stover, sugarcane bagasse, municipal solid waste, forest residues, dedicated energy crops like switchgrass and miscanthus) into ethanol while avoiding more greenhouse gas emissions and other pollutant releases compared to traditional corn and sugarcane ethanol (Williams et al., 2009). R&D activities focused on

improving the costs of acid hydrolysis and enzymatic hydrolysis—two primary conversion routes for breaking down cellulosic material into sugars for fermentation to produce ethanol. More advanced routes are in much earlier stages of the R&D pipeline (Bracmort et al., 2011; Buckeridge et al, 2012). However, many of these technologies were met with more skepticism. For example, cellulosic production routes were likely to have greater water demands compared to traditional ethanol production plants and could increase solid waste streams (Williams et al., 2009).

What proponents and critics of biofuels largely agreed upon was that some kind of governance mechanism was necessary to reduce the risks posed by biofuels. Sustainability standards, audits, and certification appeared to be the most acceptable approaches for managing the negative impacts of biofuels (Doornbosch and Steenblik, 2008; Lewandowski and Faaij, 2006; Naylor et al., 2007; Schmitz, 2007). Producer groups in less-developed countries such as Brazil warned against national initiatives that might violate WTO trade rules, leading to greater emphasis on the importance of devising voluntary standards with producers' in both developed and less developed countries. But in most governance discourses, consensus centered on the basic need for an internationally-accepted, multi-stakeholder defined criteria that could be used to track the sustainability performance of biofuel producers without triggering international trade disputes (Schlegel and Kaphengst, 2007).

Policy discussions about international standards for biofuel sustainability took root in Europe, as EU directives to replace fossil fuel energy with bio-based energy came under attack. Public criticism of the biofuel industry intensified during the Food versus Fuel debate, shining a critical spotlight on Directive 2003/30/EC (the "2003 Biofuels Directive") and Directive 2001/77/EC on the Promotion of Electricity produced from Renewable Energy Sources (the "2001 RES Directive"). The 2001 RES Directive required Member States to implement measures to encourage greater consumption of electricity produced from renewables including solar, wind and biomass in their internal markets by setting and achieving annual national indicative targets consistent with the directive and national Kyoto commitments. The 2003 Biofuels Directive specified an EU-wide target to increase biofuel consumption (by energy content) as a proportion of total petrol and diesel consumption to 2% by 2005 and 5.75% biofuels by 2010.[162]

Concerns about the social, environmental and economic risks of using crops to make fuel were established but not codified in the 2003 Biofuels Directive. Specifically, in the preamble of the 2003 Biofuels Directive, the EC promoted "research and technological development in the field of the sustainability of biofuels" and stipulated "an increase in the use of biofuels should be accompanied by a detailed analysis of the environmental, economic and social impact in order to decide whether it is advisable to increase the proportion of biofuels in relation to conventional fuels." Analysis of such impacts had not weighed heavily in setting the original targets for increased biofuel consumption. Going forward, however, the 2003 Biofuels Directive requires that the EC create an evaluation report for the European Parliament and European Council by December 31, 2006, and every two years thereafter, that reports on both the progress made in the

[162] Later the same year, the EU adopted Directive 2003/96/EC (the "2003 Energy Taxation Directive") as a support mechanism for the biofuel market, which allows Member States to create total or partial tax exemptions for biofuel providers to offset the higher costs of using biofuels for transport over fossil fuels.

use of biofuels and other renewable fuels in the Member States as well as the sustainability impacts. Article 4 of 2003 Biofuels Directive requires this report to cover:

> (a) the cost-effectiveness of the measures taken by Member States in order to promote the use of biofuels and other renewable fuels;
> (b) the economic aspects and the environmental impact of further increasing the share of biofuels and other renewable fuels;
> (c) the life-cycle perspective of biofuels and other renewable fuels, with a view to indicating possible measures for the future promotion of those fuels that are climate and environmentally friendly, and that have the potential of becoming competitive and cost-efficient;
> (d) the sustainability of crops used for the production of biofuels, particularly land use, degree of intensity of cultivation, crop rotation and use of pesticides;
> (e) the assessment of the use of biofuels and other renewable fuels with respect to their differentiating effects on climate change and their impact on CO2 emissions reduction;
> (f) a review of further more long-term options concerning energy efficiency measures in transport.

The evaluation would take into consideration annual reports by member states on their progress towards the EU wide targets of the 2003 Biofuels Directive. Whereas satisfying Articles 4(a) and 4(f) could reply upon well-established practices in policy analysis, attending to Articles 4(b) through 4(e) had few precedents.

In December 2005, the EC proposed a plan for sustainability reporting. This approach was confirmed again in the Communication on EU Strategy for biofuels issued in February 2006. In June 2006, the European Union Council on Transport, Telecommunications and Energy invited the European Commission to initiate a discussion about biomass sustainability—including certification and labeling—to provide information on the sustainability of different types of biomass and to also comment on the compatibility of minimum sustainability standards for bioenergy (EU Council, 2006). Up until this point, there had been no indication that the feed-in tariffs (pricing systems) and renewable portfolio standards (quota systems) used in either the 2003 Biofuels Directive or the 2001 RES Directive could be linked to sustainable biomass standards.

Creating special standards for biomass products could raise concerns under WTO law, which prohibits arbitrary discrimination in the trade of agricultural goods.[163] Whereas environmental standards disguised as green protectionism are considered unacceptable trade discrimination under WTO law, countries have the right to adopt standards they consider appropriate to protect human, animal or plant life or health, to protect the environment, or to protect other consumer interests if such standards are used to give domestically-produced goods an unfair advantage.[164] The WTO Agreement on Technical Barriers to Trade (TBT) allows Members to take necessary measures to implement such standards, but it is unresolved whether the TBT Agreement permits such standards if they are non-product related, meaning they target the Process and Production Methods (PPM) used to create a product and not the final product

[163] The aim of WTO Agreement on Agriculture (AoA) is to reduce trade-restricting measures and liberalize trade in agricultural products by requiring Members to replace quota systems, domestic support subsidies, export subsidies, and other non-tariff measures with "tariffs only."
[164] The WTO Agreement on Technical Barriers to Trade (TBT) allows Members to take necessary measures to implement such standards, but it is unresolved discussions on the extent to which the TBT allows for standards that are non-product related and target Process and Production Methods (PPM) used to create a product.

itself. Thus, it was unclear whether sustainability standards for biofuels would be permissible under WTO law. The EU continued to promote its impending use of sustainability standards for bioenergy, and in its 2006 communication, the Council on EU Strategy invited Member States to update their National Biomass Action Plans to address sustainability (EU Council, 2006).

7.2 Leading public regimes for biofuels governance

As the biggest importers of biofuel into the EU, the Netherlands and the United Kingdom were the first Member States to respond to the Council on EU Strategy's call for member states to address sustainability in their National Biomass Action Plans. In 2006, the UK and Netherlands began overlapping initiatives to develop criteria and indicators for bioenergy sustainability assurance. Bilateral discussions between the two countries with participation from Germany and the European Community aimed to develop a common approach to sustainability requirements that could be quickly scaled up to the EU level. In 2006, the Cramer Commission put forth a set of six sustainability criteria for biofuels. The same year, the UK government established the Sustainability Advisory Group composed members of the Cramer Commission as well as a wider set of stakeholders tasked with building from the work of the Cramer Commission to introduce a reporting framework for biofuel sustainability assurance.

These two government initiatives provided a core set of principles and criteria for biofuel producers, which influenced standard-setting in other jurisdictions. Both governments separated GHG savings as a criteria category to be dealt with separately from other sustainability issues. They decided that the majority of biofuel sustainability criteria could either be dealt with under existing sustainability standard schemes. Some criteria for environmental and social issues specific to biofuel production would need to be addressed by multi-stakeholder consultations. Criteria related to GHG savings, however, were different. No existing standards had created performance standards or assessment methodologies that could be directly applied to evaluating the GHG emissions over the lifecycle of different biofuels. Creating GHG criteria, performance standards and assessment methodology presented technical challenges to be handled through expert consultation.

Both governments envisioned implementing experimentalist governance architectures so that standards would be continually revised and improved over time. Between the two, the UK initiative elaborated on this concept by drafting a sustainability-reporting framework with a plan to progressively introduce mandatory standards. To compliment this architecture, a partnership between the British and Dutch governments, the World Wildlife Fund, and the Forest Stewardship Council (FSC) concluded that compliance with the UK reporting framework could be achieved by formalizing a "meta-standard" approach. This was part of a broader strategy led by the World Wildlife Fund (WWF) to lead the development of an international "meta-standard" for biofuel sustainability—the Roundtable on Sustainable Biofuels (RSB).

The Cramer Commission, the Netherlands

In January 2006, the Interdepartmental Programme Management on Energy Transition in the Netherlands commissioned a project group to recommend sustainability criteria and corresponding indicators for sustainable bioenergy in transportation and electricity sectors. To

comply with European directives for increasing the use of biomass, the Dutch government set two national targets: biomass-based fuels would constitute 5.75% of transportation fuel demand in 2010 (in line with the 2003 Biofuels Directive) and 9% of renewable electricity demands by 2010 (in line with the 2001 Directive on the Promotion of Electricity produced from Renewable Energy Sources). Both goals were part of a longer term goal for biomass-based energy (electricity and fuel) to constitute 30% of the total energy consumption of the Netherlands by 2040. Between 2003 and 2005, when the 2001 RES Directive entered into force, biomass-based electricity production grew significantly in the Netherlands—by a factor of seven—driven by a feed-in tariff to support the production of electricity from biomass (Junginger et al, 2007).

Implementation of the 2003 Biofuel Directive would similarly increase biomass consumption in the transportation sector. Convening this small working group represented a first step towards an eventual sustainability assurance scheme for electricity, fuels and chemicals made from a range of biomass, including palm oil, agricultural residues (such as palm kernel), wood and wood derived fuels, and solid waste streams (such as bone meal) (IEA, 2006). The group became known as the "Cramer Commission" after its chairperson Jacqueline Cramer, a professor of sustainable entrepreneurship at Utrecht University. It included representatives of private companies, social organizations, financial institutions and government.

The Cramer Commission identified a set of core criteria for sustainability in bioenergy production that could be integrated with policy frameworks at the national, European, and international levels. Its final report released on July 14, 2006 presented six sustainability criteria for Dutch companies importing biofuels for transportation: greenhouse gas (GHG) emissions, competition with food and other applications, biodiversity, environment, prosperity and social well-being. The next step would be to set performance indicators for each of the six criteria. The Cramer Commission recommended developing performance indicators based on other governance systems relevant to the sustainable production of biomass. This would help insure the Dutch sustainability assurance scheme aligned with internationally accepted standards for specific issues. For example, the Cramer Commission recommended that indicators for biodiversity criteria conform with the principles set by the Forest Stewardship Council (FSC) for using wood and by the Roundtable on Sustainable Palm Oil for palm oil. However, for feedstocks not covered by an existing sustainability scheme, new standards would be required.

The most extensive discussions revolved around the question of how to develop the GHG calculation category. In response to the EU's 2003 Biofuel Directive, the Cramer Commission recommended that a GHG calculation method follow a "well-to-wheel" approach in order to differentiate the effects that different kinds of biofuels have on climate change. Depending on how a particular biofuel is made, its emissions may vary across the major categories of GHGs emitted at different parts of the production chain, including emissions from biomass feedstock production, agricultural processing, the refining of biomass into fuel, transporting biomass and biofuel between supply chain partners, and the combustion of biofuel in vehicle engines. For example, ethanol made from corn in the US and ethanol made from sugarcane in Brazil may differ in terms of the di-nitrogen oxide (N_2O) emissions from fertilizer production and the methane (CH_4) emissions from the biorefinery that converts biomass to biofuels, but be similar for the carbon dioxide (CO_2) emissions from transporting biomass/bioenergy to end users and combusting bioenergy at the end of its life. The committee identified six calculation categories

that should be included to conduct a lifecycle assessment (LCA) for the GHG emissions of any particular bioenergy chain (Table 1). Each category required new calculation methodologies.

Table 1: Calculation Categories proposed by the Cramer Commission in 2006
• Energy and fertilizer use during the production of raw materials, regulated by standard (tabulated) emissions • Emissions involved with (indirect) change of land use • Standard load per km international transport • Energy use involved with conversion and conversion yield • Economic allocation involved with by-products (on the basis of tabulated economic value). This, therefore, means that with the use of residual flows only limited greenhouse gas emissions are attributed • The production and use of heat.

The Cramer Commission highlighted two key challenges for calculating lifecycle GHG emissions. For one, there was no existing framework; this was new terrain in regulatory science. No previous sustainability reporting framework or certification programs had required GHG calculations for agricultural commodity chains. As a starting place, the Cramer Commission advised building a carbon calculator from an existing methodology developed by the Dutch government for its UKR (Unieke Kansen Regeling) program. The UKR method covered sustainable energy management projects like carbon capture and sequestration. To adapt the UKR method, the Cramer Commission proposed expert reviews of existing methods that could be used to account for all major GHG emissions from a bioenergy supply chain. Subsequent pilot projects would test and refine this new method. This new lifecycle assessment (LCA) methodology would be used to compare the GHG emissions of different biofuel production chains to the GHG emissions from traditional fossil fuels. Depending on agricultural production methods, processing and refining technology, the GHG emissions of bioenergy production chains could differ substantially, rendering the GHG emissions of some biofuel production chains worse than that of gasoline.

The second major challenge for calculating GHG emissions was obtaining reliable data to calculate GHG balance of a biofuel supply chain. Using the traditional life cycle analysis (LCA) methodology in the ISO 14040 standard, the net GHG emissions savings for biofuels should be calculated by comparing the GHG reduction per unit fuel from producing and consuming biofuels with that of convention liquid fossil fuels from mineral oil, as well as the emissions related to reference land uses. This requires data for the various processes, resource uses, and co-products produced. Firms lacked real data on the many parameters of GHG emissions in each stage of production. To compensate, the Cramer Commission proposed establishing default values to plug into a GHG calculator. This way, if a firm had not real data available, they could use the government's default values to calculate carbon emissions. Default values would have serious implications for which kinds of bioenergy producers the Dutch government considered capable of contributing to climate change mitigation—an official justification for increasing biofuel consumption under the 2003 Biofuels Directive. Reliable default values depended on having good data on the wide range of emissions from energy and materials usage. Moreover, default values could become outdated over time. For example, if a biofuel producer improved the energy efficiency of their biorefinery by utilizing new conversion technologies, the default value for that stage of production should change to reflect a reduction in energy-related GHG emissions. This challenge could be addressed through ongoing reporting and monitoring of producers' methods.

Despite the absence of ready-to-use LCA methodologies and reliable data, the Cramer Commission proposed a GHG standard for Dutch biofuel suppliers. To count towards Dutch obligations under the 2003 Biofuel Directive, and in order to received government subsidies, suppliers would be required to show in 2007 that their biofuels come from production chains that reduce GHG emissions by at least 30 percent compared to that of petroleum-based supply chains. This "reduction threshold" would increase to 45% in 2010. The group chose the initial threshold of 30% to accommodate the largest biofuel suppliers. Existing studies indicated that using biofuels made from oil, starch and sugar crops in the US, Brazil, Indonesia and Malaysia reduced GHG emissions to the atmosphere by at least 30% compared to gasoline and biodiesel. The Cramer Commission expected that higher minimum threshold requirements of 45% by 2010 would be easy to achieve in a few years with relatively simple efficiency improvements (Cramer Commission, 2006). This would also provide ample time to collect better data from producers to improve the default values.

Unlike GHG criteria, the remaining non-GHG criteria focused on biomass cultivation and biofuel processing stages (as opposed to the lifecycle approach taken for GHG criteria) (Cramer Commission, 2006). The group chose a narrower approach to developing non-GHG criteria because it would be more efficient. Still, it would take many years to build the "watertight monitoring and registration system" required for a chain-of-custody system that can reliable track the physical flows of certified biomass crops through a production chains. In addition, extensive stakeholder consultations would be necessary to develop appropriate environmental and social standards, guide their implementation, and continually monitor firms' progress in meeting such standards in order to revise standards appropriately over the long term. Stakeholder engagement would focus attention on developing criteria that was not already covered by existing certification schemes. For example, it was unclear how to assess whether biomass production negatively impacts the "welfare and wellbeing" of a local population. It was also difficult to define long-term potential benefits, such as less poverty, better social services, or macro-economic benefits in the form of more taxes paid to governments by biomass producing companies. The Cramer Commission considered local and national stakeholder engagement as necessary, with only an acknowledgement that it may be desirable to consult foreign stakeholders from biomass producing countries (Cramer Commission, 2006: 24).

Setting a GHG reduction threshold standard was the first step in implementing an experimentalist governance system for all six criteria for biofuel sustainability. The Cramer Commission advised the Dutch Ministry of Environmental Protection to tie all six sustainability criteria to the ability to receive government subsidies and credit for fulfilling biofuel targets at a later date.

The Sustainability Advisory Group, the United Kingdom

The United Kingdom (UK) government formed the Sustainability Advisory Group in 2006, which built upon the approach charted by the Cramer Commission. The UK group comprised a wider set of stakeholders than its Dutch counterpart and included the Cramer Commission. In many ways, they picked up where the Dutch initiative left off by publishing the first mandatory reporting framework for biofuel sustainability. This meant developing more specific sustainability indicators and instituting a mandatory reporting framework. Importantly, the UK

initiative made two important contributions: they elaborated on methods for calculating GHG emissions and instituted an experimentalist governance architecture in the form of a meta-standard.

The British initiative created a reporting protocol based on many of the Dutch criteria and formalized the separate treatment of GHG criteria from other sustainability criteria. They simplified the GHG criteria to "carbon criteria" and excluded some of the Dutch social criteria. They decided that creating reporting indicators and standards on "social wellbeing" and "competition with food, local energy supply, medicines and building materials" would be too difficult to prove. The UK Department for Transport hired the consulting firm Ecofys to translate the recommendations of the Sustainability Advisory Group into reporting indicators. The indicators would constitute a reporting protocol for inclusion in the 2005 UK Renewable Transport Fuel Obligation (RTFO) (Dehue et al., 2006). In 2007, the UK released two reporting frameworks, one for carbon reporting the other for sustainability reporting (Department for Transport 2006). Although there would be no specified performance standards during the first phase of the RTFO implementation (2008-2011), reporting would become mandatory in April 2008, the year after the RTFO entered into force in 2007.

The UK modified the Dutch approach to GHG calculation and performance standards. Like the Dutch, the British group proposed minimum reduction thresholds for the lifecycle GHG emissions of biofuel production chains and delayed assigning performance standards for the other sustainability criteria until more extensive stakeholder consultations. The UK group based their standards on the same set of studies as the Dutch, but they proposed a higher GHG reduction target of 40% by 2008-09, rising to 60% by 2010-11 (Dehue et al., 2008; Dehue et al., 2007). Overtime, the UK planned to ratchet up its minimum emission reduction thresholds.

Whereas the Cramer Commission proposed a LCA framework that assumed a straight forward supply chain, the British advisory group's methodology incorporated more complex supply chain scenarios. Like the Dutch, the British approach to GHG calculation also embodied a "well-to-wheel" approach for assessing the lifecycle GHG balance of bioenergy supply chains. However, the British framework was more robust. Rather than assume that biomass feedstock production comes from a plot of land, the British framework included the possibility that feedstocks could be the residual product of another industrial process. It also considered that emissions would be different depending on the co-products made from the same process (e.g. ethanol and dried distillers grain and solubles). This approach would enable more accuracy in assessing the emissions from dynamic production systems. This would render different kinds of systems more easily comparable and make aggregation easier. If any supply chain actor shifted its production method or purchasing strategy, the methodology for a specific module could be adjusted. This would require separate component methodologies for different production activities. To calculate emissions for an entire supply chain would entail aggregating the emissions from various modules of a particular biomass-to-fuel supply chains (Elghali et al., 2007). Whereas the Dutch approach conceived of fuel suppliers hiring independent auditors to verify the emissions for an entire supply chain, the British modular approach mimicked the FSC model of having each actor in a supply chain responsible for hiring an independent auditor to verify its emissions, which then get passed to the next actor in the chain (Dehue, et al., 2007).

Like the Dutch government, the UK planned to introduce targets for fuel suppliers' sustainability and carbon performance. This meant that in order for fuel suppliers to obtain RTFO certificates demonstrating their compliance with the law, they would have to go beyond the original reporting requirements of the RTFO: not only would they need to show they marketed the requisite volume of biofuel, but they would also need to report on their sustainability and carbon performance.[165] Once the UK RFTO Sustainability Reporting Framework was in place, the RFA planned to introduce a set of mandatory performance standards in 2010 for sustainability and carbon savings (Dehue et al., 2008).

The "Meta-Standard" as an experimentalist governance architecture

The UK and Dutch advisors conceived of biofuel sustainability assurance as an experimentalist governance system and aimed to facilitate the construction of what I term a "coordinated regime complex" for biofuels governance. As a project team hired by the WWF, FSC, and the British and Dutch governments concluded, "a situation in which each country has its own national scheme in place is likely to be inefficient, less effective, and will constrain the international development of the bioenergy sector" (Dehue et al., 2007: 61).

The UK decided that compliance with most non-GHG performance standards could be achieved through what the WWF and FSC recommended as a "meta-standard" approach. Rather than create a new set of extensive standards for biofuels, a meta-standard approach leverages the standards of well-established sustainability schemes. A "meta-standard" is a set of high-level criteria and performance requirements that serve as benchmarks for compliance using other certification schemes. The criteria and standards set by the meta-standard serve as benchmarks for determining "qualifying standards." If an existing standard meets the minimum standards of the meta-standard, including having proper auditing and certification procedures, it becomes a "qualifying standard."

Whereas compliance with GHG standards would be carried out by independent auditors using the UK carbon calculator, compliance with most non-GHG sustainability standards would be met through existing certification standards. The UK decision to pursue a meta-standard came from a study commissioned by the partnership between the Dutch and British governments, the WWF and the FSC, which concluded that a meta-standard would be the most efficient way to implement the UK RFTO reporting protocol, given the short time frame for rolling out performance standards into the RTFO Sustainability Reporting Framework (Dehue et al., 2007). In theory, a biofuel supplier could use crop-specific sustainability schemes to comply with the

[165] Under 2005 RTFO, any road transport fuel supplier who supplies more than 450,000 liters of fossil fuel per annum to the UK market must allocate a specified percentage of their sales to renewable fuel. Suppliers can fulfill their obligation with any combination of biofuel, including ethanol, biodiesel, biogas or other biomass-based road transport fuel. To obtain an RTFO certificate, fuel suppliers must file online reports to the Administrator of the RTFO, the UK Renewable Fuels Agency (RFA). In these reports, suppliers must prove that 2.5 percent of the fuel they marketed was renewable fuel in 2008-2009, and 5% for 2010-2011. For each liter of renewable biofuel they report putting on the UK market, the fuel supplier receives one RTFO certificate. They may also purchase certificates from other fuel suppliers to meet the RTFO. Without adequate certificates proving they met their annual obligation, a fuel supplier must pay a buyout price for missing liters, essentially a fee that compensates for each liter of renewable fuel that they failed to put on the UK market. If fuel suppliers failed to meet the mandatory reporting requirements, they would have to purchase RTFO certificates from other fuel suppliers or else pay the buyout price to compensate for their lack of certificates.

UK RFTO reporting protocol, like the FSC, the Better Sugarcane Initiative, Roundtable for Responsible Soy, and Roundtable for Sustainable Palm Oil Production. Most of these crop-specific schemes also act as meta-standards on specific issues. For example, the FSC requires compliance with other certification programs to address issues for which existing, robust standards already exist[166], such as human rights and labor issues.

The Cramer Commission recommended a similar strategy for its social criteria on working conditions, which is defined as compliance with the certification program Social Accountability 8000 (SA8000), the Tripartite Declaration of Principles concerning Multinational Enterprises and Social Policy compiled by the International Labor Organization (ILO), and the Universal Declaration of Human Rights.

Despite the efficiency of using standards from established schemes, important gaps remained. The British project team concluded that for biofuels, there was no single voluntary standard that would meet the full requirements of the UK RFTO meta-standard. Thus multi-stakeholder consultations would still be needed, but their scope of work would be reduced to focus on developing new criteria, standards and metrics for the gaps left by qualifying standards. For some criteria, there was unresolved political tension between environmentalists and the private sector. For other criteria on displacement effects there was no precedent. For example, the UK project team deemed standards for competition between food and biofuels too challenging to address early on. The UK resolved to create gap criterion for carbon stock conservation and food competition.

The meta-standard approach embodied by the Dutch and British government's initial reporting standards laid the groundwork for an experimentalist architecture to take shape within a coordinated regime complex for biofuels governance. As discussed in Chapter 6, experimentalist regimes arise when public officials and other policy leaders are uncertain about both the definition of the problem and its solution. In such situations, stakeholders may find it difficult to map proposed solutions onto their interests and therefore become more open to good-faith deliberations to determine how their interests intersect with public interests. The cornerstones of experimentalism involve deliberative goal-setting, monitoring performance, peer review, and recursive learning.

The approach devised by the UK RFA endeavored to lay the groundwork for an experimental architecture to grow by requiring biofuel producers selling into the UK market provide performance data. This would allow the RFA to monitor suppliers' performance and to evaluate which producers were leaders versus laggards, all towards having greater insight for introducing mandatory performance standards for sustainability and carbon savings at a later date (Dehue et al., 2008). Beginning in 2011, the receipt of RFTO certifications would depend on a supplier's ability to demonstrate that the biofuel they marketed in the UK met minimum

[166] For example, in 1999, the FSC General Assembly passed a motion requiring compliance with all forestry-relevant conventions under the International Labour Organization Conventions (ILO), such as codes on the Practice on Safety and Health in Forestry Work, Force Labor and the Abolition of Forced Labor, Minimum Age and Worst Forms of Child Labor (FSC, 2002). In 2002, the FSC implemented this decision with new rules that require all forest managers to comply with all ILO conventions that impact forestry operations and practices, for all countries, even those countries that have not ratified forestry-related ILO conventions.

performance requirements. Reporting would also provide the RFA will monitoring data needed for peer review. Overtime, these standards would be tightened, both to push firms towards better performance as well as to accommodate new information on biofuel impacts (Dehue et al., 2007). More stringent carbon and sustainability standards could potentially offset the impact of future increases in European biofuel consumption targets under the 2003 Biofuel Directive, providing a built-in mechanism for ratcheting up producers' sustainability performance.

Although the meta-standard approach was not new conceptually, it was a novel way to help coordinate the expected proliferation of public regimes. Other governments were not as far along as the British and Dutch initiatives. Germany, Belgium and Switzerland were also working on integrating sustainability reporting into their bioenergy policies. In the US, Californian regulators were well underway in developing GHG methodologies for their Low Carbon Fuel Standard, with US EPA regulators trailing the Californian developments in preparation for issuing new rules for the US Renewable Fuel Standard. The meta-standard approach would also help reduce transaction costs for firms by increasing harmonization across government sustainability standards.

From this perspective, the meta-standard approach offered a strategy for harmonization by creating connective tissue between it and other regimes. It aimed to provide the scaffolding for a nested architecture in the biofuel regime complex. The meta-standard would not necessarily be positioned hierarchically in relation to its qualifying standards, as it would have no direct authority over other regimes. However, it offered a coordinative architecture: when the meta-standard tightens its standards, a qualifying standard may choose to do so too in order to maintain their status with the meta-standard, or conversely, a meta-standard may choose to not tighten its standards in order to contribute to the legitimacy of a qualifying standard.

7.3 Leading private regimes for biofuels governance

This section reviews the private governance regimes emerging from non-state arenas, primarily in Europe. Given the WWF's ability to secure strong initial backing from a coalition of international organizations including the UN Foundation, the FAO and others, little competition emerged to challenge the RSB (cf. the industry-led competition that emerged to challenge the FSC as described in Chapter 6). Moreover, the World Wildlife Fund (WWF) led the creation of the Roundtable on Sustainable Biofuels as part of a broader initiative to develop a coordinated regime complex, consisting of parallel public and private regimes that would work to reinforce each other.

The World Wildlife Fund and the Roundtable on Sustainable Biofuels

Between the spring and fall of 2006, WWF-Germany convened an informal Berlin-based group called the "Biomass Round Table" to discuss global governance strategies for the burgeoning biofuels industry. The group identified a core set of sustainability standards that would address potential problems arising from increased bioenergy (WWF Germany, 2006). They proposed the "ideal" way to implement such standards would be under an international framework agreement on core sustainability criteria for the different kinds of biomass-to-energy production chains (WWF Germany, 2006, p. 42-44). The goal of an international framework

agreement would be to guide the creation of detailed, mandatory EU-level and national-level regulations under the 2003 Biofuels Directive. The WWF Biomass Roundtable intended to push governments to go beyond the minimum criteria of the international framework. To do this, the group envisioned the creation of a parallel private standard scheme, such the certification programs developed by WWF roundtables. These parallel systems would effective function as a coordinated regime complex of public and private certification bodies that would be responsible for monitoring and verifying the implementation of these sustainability standards.

To develop the biofuels regime complex, the WWF-Germany Biomass Round Table proposed a two-pronged approach comprised of short- and long-term strategies (Fritsche 2006: 42-46). The long-term strategy focused on an international framework, but in the meantime, the group advised the WWF to lead a core group of actors to raise resources for creating a private biofuel sustainability certification program. Specifically, they recommended partnering with international players like the United Nations Food and Agriculture Organization (FAO), the Global Environmental Facility (GEF), the United Nations Foundation (UN Foundation) and the Global Bioenergy Partnership (GBEP)—a G8 initiative initially focused on developing technical standards for biofuels but that was increasingly interested in broadening their mandate to formulating sustainability standards as well. Many of these organizations had already devoted resources to internal program work on bioenergy sustainability, including UNEP, GBEP, IEA, and FAO. These partners would be key in providing visibility and financial resources. They would also provide a supportive coalition needed to endorse the initiative's sustainability standards should competitors arise.

This short-term strategy also would involve working closely with national governments. Because an international framework would take years to develop, the Biomass Round Table recommended that governments begin to pass legally-binding negative standards at the national level—essentially these would be minimum standards based on the "avoidance of" certain impermissible activities. The recent EU communication that Member States should update their National Biomass Action Plans with sustainability rules in anticipation of impending EC legislation meant that there would soon be a proliferation of sustainability standards for biofuels coming from European governments (EU Council, 2006). Rather than wait for EC legislation, the project team advocated implementing standards in the short term through bi-/multi-lateral trade agreements between the EU and major producer countries like Brazil or South Africa[167]. As short-term agreements, they would serve as pilot projects that could inform EU-wide legislation on mandatory standards.

Important to both long-and short-term strategies, the group recommended further exploration into how existing voluntary standards could be merged with existing regulatory approaches, including the commodity-specific roundtable approach that the WWF had already invested many resources in (WWF Germany, 2006, p. 43). Beginning in 2002, WWF launched a series of commodity-specific "roundtables" to develop certification schemes. The goal of commodity roundtables is to develop sustainability certification programs that facilitate consistent demand signals from downstream supply chain actors (e.g. namely retailers, consumer goods companies, and food and material processors) to support the supply of sustainably-produced commodities. First, WWF forms buyers' groups of retailers and other downstream

[167] This suggestion appears to be similar to the EU FLEGT bilateral agreements. See Chapter 4.

actors that are willing to make public commitments to sourcing sustainable commodities. This practice can be considered a more institutionalized version of the earlier WWF buyers groups for sustainable wood in the 1990s (See Chapter 6). Once powerful market actors are on board with sustainability commitments, WWF leads the development of a roundtable comprised of stakeholders with environmental, social and economic interests, including retailers, investors, traders, producers, NGOs, community groups and academics. This body then uses a multi-stakeholder governance process to devise global standards on sustainable commodity production through a multi-stakeholder process. The desired result is an FSC-like certification system to address severe sustainability issues for a particular commodity.

The first roundtable launched in 2002, organized by WWF-Switzerland, WWF-Indonesia and WWF-Germany in partnership with the multinational Unilever (one of the biggest players in palm oil trade) and the international NGO Solidaridad (group focused on creating fair and sustainable supply chains). The group included major retailers, food manufacturers, palm oil processors and traders, and financial institutions that shared an interest in addressing severe sustainability issues in the palm oil sector. Like the FSC, the resulting Roundtable for Sustainable Palm Oil (RSPO) acts as a democratic multi-stakeholder body dedicated to creating and implementing a certification system.

Despite the mixed success of the RSPO, WWF subsequently launched more roundtables to build supply chains for agricultural commodities with sustainability credentials (Schouten, 2013).[168] In 2004 WWF initiated the Roundtable on Responsible Soy (RtRS), which attempted to address some of the shortcomings of the RSPO by following the FSC model more closely[169] (Schouten, 2013). Also in 2004, WWF-South Africa initiated a pilot project later called the Sustainable Sugarcane Farm Management System (SusFarMS) in partnership with South African sugarcane growers and the Mondi Wetlands Project to provide input into the WWF Better Sugarcane Initiative (BSI) (WWF, 2015). The BSI created a global performance-based standard for sugar production, now known as Bonsucro.[170] In 2005, WWF began the Better Cotton Initiative (BCI) to promote measurable improvements in the economic, environmental and social

[168] The RSPO focused on the developing indicators and measurable standards of sustainable palm oil. Members commited to help recruit other private sector players; use their supply chains to field test the proposed standards and help develop meaningful chain of custody/traceability systems; purchase product from producers in transition; make meaningful targets for their own purchases (e.g. 25% of supply within 10 years) and ratchet these target upward, and; promote the adoption of the system, even if not directly involved as is the case for banks and investors. The first version of the RSPO certification system launched in 2007 with the first certified sustainable palm oil available in November 2008. Although membership is relatively large (over 700 members), the number of firms implementing the standard lags; after the first three years, only about 10% of global palm oil supply was certified with very few companies submitting annual reports publicly (Schouten, 2013).

[169] Both of these roundtables have suffered from representational problems and experienced slow uptake in their respective global supply chains. However, each has succeeded in establishing small but steady supplies of certified products. Schouten (2013) explains that critics of the RSPO pointed out that by giving every member an equal vote, the RSPO General Assembly was dominated by industry constituencies with the most membership, which undermined the basic multistakeholder governance criteria for inclusion and consequentiality. For the RtRS, WWF invited a more balanced set of stakeholders to the first meeting, and the founding group chose to implement equal voting for three stakeholder groups Producers; Industry, Trade and Finance; and Civil Society (with no voting rights for the fourth stakeholder group, Observers).

[170] Bonsucro released its first set of standards in November 2010

sustainability of cotton cultivation. Although the BSI and BCI are not roundtables in name, both initiatives created voluntary global governance systems in the roundtable mold.

WWF International took the next steps to pursue both of the recommended short- and long-term strategies for biofuels governance by creating a private, voluntary certification scheme based on a "meta-standard" of biofuel sustainability that leveraged existing roundtables and other sustainability standard schemes. Specifically, the project group evaluated how a hypothetical sustainable biomass scheme would interface with the Roundtable on Sustainable Palm Oil (RSPO), the Forest Stewardship Council (FSC), and the Pan-European Forest Council (PEFC). They concluded that most of the core elements for a sustainable biomass scheme already existed in these schemes, but would require detailed elaboration to address the diversity of biofuel products.

WWF International launched an initiative in fall of 2006 called the Roundtable for Sustainable Biofuels (RSB). WWF envisioned the RSB as a hybrid global governance system. On one hand, it would be a privately run, voluntary experimentalist governance system like the FSC.[171] Its principles, criteria, standards and rules would be developed through multi-level stakeholder engagement; Once international criteria were set by a general assembly with inclusive representation of major stakeholder groups engaged in a rigorous process of deliberative democratic decision-making, a rigorous, inclusive process of, national and regional satellite groups would form multi-stakeholder governance bodies to adapt the international criteria into locally appropriate standards and metrics. With the approval of an international secretariat for the RSB, biofuel producers and suppliers would be able to apply for RSB certification. Over time, the RSB general assembly and its satellite bodies would update the standards with an eye towards ratcheting firms' performance upwards as well as improving the harmonization of local-level adaptations of the standard.

Compared to previous WWF roundtables, the scope work of the Roundtable for Sustainable Biofuels (RSB) was larger and more complex. The RSB would have to devise standards for not just one, but many different kinds of commodity production chains. The term "biofuel" encompasses multiple fuel commodities—from better known fuels like ethanol and biodiesel to lesser known fuels like biobutanol and other fuels that can be made from biomass. It also includes multiple production pathways for each category of biofuel. For example, a biodiesel production chain can originate in a palm oil plantation in Indonesia or a soybean plantation in Argentina. An ethanol production chain may start in the US Corn Belt or in the sugarcane-growing state of Sao Paulo, Brazil. Given variation of unique biofuel production chains, creating a comprehensive set of standards for all biomass-to-energy production chains would be a significant undertaking.

In addition, developing an international framework would require lengthy consulting and decision-making processes to ensure acceptance by all the relevant stakeholder groups. The Roundtable on Sustainable Biofuels would build upon WWF's ongoing multi-stakeholder roundtables approach to standards development for commodities with the largest environmental impacts (e.g. Palm oil, sugar, beef, cotton). Like previous WWF roundtables, the RSB recruited representatives of key organizations and stakeholder groups to develop its standards.

[171] See Chapter 4 for an explanation of the FSC model.

In 2007, the Roundtable on Sustainable Biofuels established a secretariat at the University of Lausanne in Switzerland and launched a three-year, global initiative to collect feedback from relevant stakeholders. During this time the RSB traveled the globe. A small but dedicated staff conducted outreach with a diverse array of stakeholders in over ten countries, spanning both hemispheres with a majority of meetings held in the Global South. In each place, they hosted numerous consultations open to anyone and collected feedback from participants on its various categories of indicators, and maintained an open membership policy. This approach was designed to secure buy-in early on from important groups, especially the private sector and developing countries, thereby avoiding challenges to the RSB's legitimacy later.

In 2010, after almost four years of multi-stakeholder meetings, field-testing in pilot projects, and final public consultations, the RSB global meta-standard was released for use the following year. RSB membership is remarkable in both quantity and breadth, with RSB members from more than thirty countries, representing different actors along various biofuel supply chains. By this time, discussions of developing an international agreement for biofuel sustainability had subsided amid various developments in national and subnational jurisdictions. The meta-standard in many ways fulfilled this goal. Moreover, as an organization the RSB was well positioned to collaborate with governments in their development of mandatory standards that would be compatible with the RSB. As discussed in the sections below, the question of how to adequately address GHG savings became a focal area of RSB. They developed an online GHG calculator and other tools to ensure that biofuels operators can measure and report on GHG savings.

The Global Bioenergy Partnership

Initially, the Global BioEnergy Partnership (GBEP) appeared positioned to lead a competing sustainability standard-setting initiative. GBEP was originally established as a joint effort led by G8 countries plus Brazil, China, India, Mexico and South Africa, with support and participation from the International Energy Agency (IEA), the FAO, and the UN Foundation to address hurdles for increasing biofuels trade. Its participants included representatives from the governments of major biofuel producing nations and industry associations.

The GBEP's original focus included devising technical standards, but in 2007 the GBEP broadened its mandate in the midst of the food-v-fuel controversy to include an initiative to develop "global science-based sustainability criteria and indicators." GBEP emphasized its approach as expert-based to distinguish it from the RSB's multi-stakeholder approach. It launched two task forces in 2007/2008. The GBEP Task Force on Sustainability would develop "neutral" social and environmental criteria that avoid ascribing any directionality to the performance aspects of proposed criteria. The GBEP Task Force on GHG Methodologies would create a methodological framework to guide members when devising national GHG methodologies to assess biofuels. Unlike the RSB's approach, the GBEP would not prescribe performance values to biofuel producers. Eventually the GBEP shifted its focus to concentrate on advising governments and the industry on methodological developments regarding factoring in indirect land use change into lifecycle GHG calculations.

The International Standards Organizations

In addition to the RSB and GBEP, the International Organization for Standardization (ISO) announced in 2009 that it would create a new international sustainability certification program for bioenergy.[172] After requests to ISO from a number of countries including the Netherlands, the US, Sweden, Brazil, and the UK, a project committee (the "ISO/PC 248") formed bringing together a group of international experts to work to identify criteria and indicators on social, environmental and economic impacts by the end of 2012. Twenty-nine countries participated with Brazil and Germany providing leadership and hosting the secretariat. The United States and China participated as observers without voting rights. Given ISO created the first international standard for attributional LCA (as part of the ISO 14000 environmental management standards), the project committee for bioenergy sustainability will likely examine the issue of modeling GHG emissions through attributional and consequential LCA in depth.

7.4 Key conflicts shaping the definition of sustainability criteria and low-carbon value

In this section, I highlight a select group of issues that drew intense debate within the biofuels regime complex. There were a number of questions that emerged in the UK and Netherlands regarding the design of environmental and social criteria, including how to address biodiversity, genetically modified organisms (GMOs), and the social impact of the displacement of food crops. However, in both contexts, the problem of how to assess the low-carbon value of different biofuel commodity chains increasingly took center stage. While many environmental and social issues fell under the sustainability criteria already established in other industry codes of conduct and certification programs, GHGs lacked any internationally accepted methodology on which regulators could base GHG performance standards. Without this, trade disputes over GHG standards were likely. However, give the need to justify the increased use of biofuels as having a positive impact on climate change, neither body could avoid the GHG calculation question. As discussed in the next section, this was complicated by disagreement among experts over how to model displacement effects and the need for any GHG calculation methodology to represent the interests of a diverse group of stakeholders, lest it be deemed illegitimate by biofuel producer groups.

Defining biodiversity and the permissibility of genetically modified organisms

On issue of biodiversity, there was general consensus that biomass plantations not be located in or near protected areas containing valuable biodiversity. However, differences emerged regarding how to define "valuable." The Cramer Commission questioned whether "valuable" should be defined by importing countries, by international institutions, or by producing countries. The UK RTFO approached the issue with three biodiversity indicators designed to account for local variability: evidence of compliance with local laws and regulations, as determined by an Environmental Impact Assessment; evidence that production activities do not take place on High Conservation Value (HCV) areas, as determined by a HCV assessment of the biological, ecological, social and cultural value of an area, and; evidence that endangered

[172] For more on the ISO 13065:2015 Sustainability for Bioenergy, see ISO (2015).

species habitat would not be damaged.[173] However, HCVs remain undetermined for many areas.[174] In the absence of comprehensive maps of HCV areas, the UK criteria referred to international biodiversity conservation authorities such as the IUCN to help specify areas considered of importance for the conservation of biodiversity (Dehue et al., 2007).

A second issue emerged around the issue of how to treat GMOs in biodiversity criteria. The Cramer Commission project group was divided on whether to include anti-GMO indicators in its biodiversity criteria. In the EU and internationally, regulation limited the import of genetically modified food and feed.[175] However, scientific debates about the impacts of GM cultivation on biodiversity remained inconclusive.[176] Groups like the World Conservation Union (ICUN) have warned that the indirect impacts of GM cultivation are significant, despite inconclusive evidence. Because GM cultivation is a monoculture technique, evidence of harm to biodiversity and ecosystems is well established, including habitat change (land use change and physical modification of rivers or water withdrawal from rivers); pollution; and invasive species (IUCN 2007).

However, the Dutch group took a strong position on GMOs as part of their biodiversity criteria due to the potential for trade-related disputes. An anti-GMO indicator could disadvantage corn ethanol imports from the United States in favor of sugarcane ethanol imports from Brazil—the two largest ethanol-producing countries. Such a scenario could invite trade disputes from countries with producers using genetically modified (GM) biomass to make biofuels for the European market. Despite environmentalists' position that GMOs were best addressed under the biodiversity criteria given the well-established relationships between GM cultivation, monoculture, and biodiversity, the group reasoned that GMO criteria could be better addressed at a later date under the category of food security issues (Cramer Comission, 2006: iv). As a compromise, the group suggested that reducing the environmental risks of GMOs be accomplished with a standard that initially requires compliance with the relatively weak US legislation on GMOs by 2007, with compliance with more stringent EU legislation in 2010.

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[173] For a definition of the 6 High Conservation Values, see HCV Network (2015), which include criteria for protecting biodiversity of species, landscapes, rare and/or threatened ecosystems, ecosystem services, indigenous and/or local communities, and cultural heritage sites.

[174] HCV assessments are required to involve local stakeholders and conservation NGOs to determine the presence or absence of HCV.

[175] Under the revised Directive 2001/18/EC on the environmental release of GMOs, the EU has the most stringent import regime for GMOs. GMOs placed on the market or released into the environment must be approved by the European Food Safety Agency. At the time of writing, only one GMO—a Monsanto brand of corn GMO MON810—is currently allowed to be cultivated in the EU, specifically in Spain, Portugal and the Czech Republic; around 50 GMOs are approved for import as animal feed or food products into the EU market, mostly maize, soy, rapeseed and sugar beet varieties, and; blocked import licenses remain for 19 GMOs including food, animal feed and flowers. As of April 2015, the EU plans to simplify the import approval process for GM products, allowing members states to decide whether to admit them or not. See, Harvey (2014). Moreover, the 87 adoptees of the Cartagena Protocol on Biosafety had strengthened efforts to promote the safety of international trade in GMOs by adopting labeling requirements for all bulk shipments of GMOs and living modified organisms (LMOs) intended for food, feed or processing (such as soybeans and maize) in 2004.

[176] Although laboratory experiments demonstrated direct impacts of GM applications on non-target species and gene flow, evidence of direct impacts of monoculture GM crops on biodiversity was inconclusive. Furthermore, indirect impacts including cases of contamination often have been linked to poor management of GM cultivation (ICUN, 2007).

The British group also did not address GMOs in their RTFO reporting framework. The UK Sustainability Advisory Group based its biodiversity indicators on the concept of High Conservation Values (HCV)—a concept introduced by FSC. This approach emphasized compliance with local laws and regulations and the use of an HCV assessment to determine whether production activities take place in or near HCV areas. This left the question of GMO usage to local authorities in conversation with international standards for what constitutes a HCV area. Thus, both the Dutch and British groups relegated the GMO issue to other public and private regimes with well-developed GMO rules.

Addressing displacement effects

Addressing the multiple displacement effects of biofuels production became a central focus of deliberation in the biofuels regime complex. Before 2005/06, the issue of the negative "indirect" effects of expanding biomass production in the press, scientific literature, or industry and government reports appeared as a general concern about changes to commodity prices, shifts in the balance of trade and global import/export patterns. As the expansion of biomass markets accelerated, attention increased around the potential negative effects on raw material prices in the forest industry and for food crops like sugarcane and corn and the potential environmental and social impacts of such effects (Dufey and Grieg-Gran, 2006, p. 45).

The "Food versus Fuel" backlash framed biofuel production as a threat of "displacement" of food crops thereby translating indirect effects into social justice terms. In theory, diverting greater amounts of biomass commodities to liquid transportation fuel markets would increase the overall demand of commodity markets for sugarcane, corn, soy oil and palm oil. Increased demand on agricultural commodities would result in higher international prices in the short term. Farmers, responding to the increased demand for biomass created by international biofuel market, would market fewer agricultural commodities to food and feed markets. The increased demand for biomass for food and feed would increase food prices. Eventually prices would fall again, once producers compensated for displacement by expanding the production of displaced crops. However, this would increase competition for land as producers seek to expand production to take advantage of higher commodity prices. In effect, higher international commodity prices would intensify competition between land used for cultivating food security and land used for cultivating export crops (Tenenbaum, 2008; FAO 2008; Mitchell, 2008).

Following this causal chain, biofuel critics claimed that biofuels posed a serious food security threat to the world's poor. Economically vulnerable populations in net food importing countries and the urban poor in food producing countries would suffer the greatest, not being able to afford spikes in food prices nor invest in local food production. Economists, however, remained inconclusive about the relationship between corn-for-ethanol production and global food prices (Tenenbaum, 2008; FAO 2008; Mitchell, 2008).

The issue of displacement could also negatively impact the low-carbon value of biofuels. The Dutch and British project teams worried that displacement posed risks to carbon conservation, and thereby alter the GHG balance of various biofuel supply chains. This would undermine the rationale for consuming more biofuels. The general logic was that the increased demand for biomass would expand farming production throughout the global agricultural sector (Dehue et al., 2007). The UK and Dutch project teams identified a number of concerning

scenarios. First, farmers could bring new land into production by converting "natural" forests and grassland into new agricultural land. Or, they could expand cultivation into "idle" or "degraded." Although there was no internationally agreed upon definition for "idle" or "degraded", both terms used interchangeably to refer to marginal land that is not as productive as regular cropland due to soil topography, water scarcity, or poor management practices (Dufey, 2007). Such marginal land can include pastureland, previously harvested forestland and cropland, or conservation land taken out of production as in the case of US lands place in the US Conservation Reserve Program (CRP).

Land use change (LUC) on both "natural" and "marginal" lands would not only threaten biodiversity and habitat, but could also destroy large stocks of carbon and other GHGs ("carbon stocks") stored below ground in the soil or above ground in vegetation. Converting forest, grasslands, peatlands or idle/degraded land for new agricultural land uses releases GHGs instantly or overtime. The FAO and the IPCC estimate tropical deforestation and forest degradation to account for somewhere between 17% and 25% of GHGs from human activity (Tubiello et al., 2014; IPCC, 2007). More recent research puts this figure at about 10% (Baccini et al., 2012; Harris et al., 2012).

This risk highlighted a number of components that may affect the quantity of GHGs released from carbon stocks, including the net uptake of carbon by vegetation, the decomposition and respiration of plants after peatlands drainage, the use of fires, and releases of GHGs like methane (CH4) and nitrous oxides (N2O) that have a much higher heat-trapping effect when compared to CO2 (Hooijer et al., 2010). Sources of fire not only include slash and burn deforestation, as well as agricultural harvesting methods. In Brazil, burning the leaves and tops of mature sugarcane crops has been practiced for over a century as an operationally efficient way to harvest, transport and process sugarcane into sugar and ethanol. The decomposition of peatlands and mangroves that results after drainage of these lands for agricultural purposes can result in a huge loss of carbon-storing potential, given that mangrove soil alone stores up to four times more CO2 than trees, in addition to CH4 and N2O (Hooijer et al., 2010). Such emissions are especially high in Southeast Asia. Reports have shown that increased demand for palm oil for European biodiesel markets contributes to greater deforestation and drainage of peat swamp forest, particularly in Indonesia and Malaysia (Stone, 2007).

The project teams identified alternatives unwanted LUC. Farmers could invest in higher-yielding biomass crops. Or, farmers and biofuel producers could shift their supply chains away from biomass that carried a high risk of displacing other crops, towards alternative such as perennial energy crops like switchgrass or waste products such as agricultural crop residues like corn stover or industrial biomass wastes from agricultural processing plants. However, obtaining higher yield and using alternative sources of biomass produced from large monoculture crops could reinforce unsustainable agricultural practices by encouraging the use of genetically-modified crops, alien species, and the use of pesticide and herbicide inputs.

This exposed new tensions between biodiversity conservation and mitigating the negative "displacement" or "indirect" effects of expanding biomass production. To ensure that mitigating negative displacement effects did not undermine biodiversity criteria, the UK project team sought more to develop a mechanism for encouraging higher yields via sustainable agricultural

practices. One approach discussed was an incentive that rewarded sustainable agricultural performance that demonstrated exceeding a sector-specific average. This could be accomplished through more extensive commodity certification schemes, like the Roundtable for Responsible Soy (RfRS) and the Roundtable for Sustainable Palm Oil (RSPO), which offered a system of tradable certificates for biomass originating from sustainable plantations (Dehue et al., 2007). The RSPO has a separate chain-of-custody certification audit for non-GMO palm oil production. However, in both schemes lack anti-GMO requirements and permit the introduction of non-native, alien or invasive species.

Other unwanted displacement effects identified as threats to biofuel sustainability included land use changes that push local people off their land or violate their land rights in some way. Compared to the less visible unwanted displacement effect on biodiversity and carbon stocks, social displacement effects like land grabs could be more easily traced assuming mechanisms could be put in place to monitor and communicate local grievances. Given that commodity markets are global, displacement effects cross national and sectoral borders, making it difficult to know where displacement occurs. For example, regulations in one country designed prevent deforestation or land grabs related to expanding biodiesel crops could increase the risks of deforestation in another country, where weaker national regulations govern a different biodiesel crop.

Mitigating the unwanted displacement effects of reduced carbon stocks and increased competition with food was uncharted territory. Previous transnational regulatory standard setting and certification scheme had not developed criteria to document the GHG balance of a commodity. Existing commodity-focused certification schemes like the Roundtable on Responsible Soy, the Roundtable on Sustainable Palm Oil, and the FSC did not hinge on achieving a positive contribution to GHG reduction compared to the fossil fuels. Nor were there existing protocols for competition with food. To address both issues, the project teams proposed that additional demand for agricultural commodities from the energy sector be met by alternative sources of supply, namely via the cultivation on idle/degraded/marginal land, the use of higher yielding crops, and the use of waste feedstocks (Defue et al., 2007, p. 43).

Avoiding disputes at the World Trade Organization

There was no consensus within the regime complex about how unilateral sustainability standards might be treated in a World Trade Organization (WTO) dispute. Among trade law advisors to the British and Dutch governments, there was agreement that sustainability reporting alone would not advantage the biofuels of a domestic producer over a foreign one given neither the UK nor the Netherlands had much of a domestic biofuel industry. However, sustainability performance standards remained a grey area in international trade law. Key advisors to the Dutch government advised against sustainability criteria for biofuel imports due to the likelihood of trade disputes. Sustainability criteria could increase the costs of production for producers in less-developed countries substantially—as much as 50 percent on top of the EU import tariff of €0.19 per liter (Van den Bossche et al., 2007). This would make it difficult to refute claims of green protectionism given that ethanol imports from Brazil and biodiesel imports from Southeast Asia are cheaper than biofuels produced in Europe even when the subsidies and border tariffs are accounted for (Erixon, 2012).

At issue was how the WTO Technical Barriers to Trade (TBT) Agreement may be applied to biofuel sustainability and GHG performance standards. The TBT requires that environmental and social standards — be they nationally mandated or voluntary standards — not create unnecessary barriers to free trade by favoring the 'like' products of one WTO member over another. Some WTO member countries have asserted that sustainability standards are not covered by the TBT as long as they do not systematically disadvantage imports over domestic products (Zarrilli 2006). However standards that result in product bans have been difficult to uphold. GATT and WTO dispute settlements panels had previously found sustainability standards that target the methods of producing a particular product—rather than the product itself—to be trade discrimination (Erixon, 2012). If regulatory standards targeting process and production methods (PPMs) treat domestic products more favorably than foreign products that would otherwise be competitive with 'like' domestic products, trade disputes are likely to arise.

Advisors to the UK government considered biofuel standards likely to survive challenges in the WTO given that such standards aligned with the UK's national policy objective of reducing GHG emissions (Dehue et al., 2006; Farrell et al., 2007). Under the planned implementation of the RFTO in 2011, only those biofuels which met minimum sustainability and carbon savings performance requirements would be awarded RTFO certificates, effectively banning poor performing biofuels from counting towards fuel suppliers' RTFO commitments. The UK strategy was to avoid impinging on WTO rules by stipulating that reporting on ecological and social standards was not a requirement for access to the UK market, but merely a condition for obtaining RTFO certificates. However, it is less clear that WTO law permits certification labels that relate to PPMs. This issue is still being discussed in the WTO. Subsidies for agricultural products may become more controversial if a new round of negotiations is initiated in the WTO.

GHG performance standards posed a greater conundrum. Absent an internationally accepted methodology for calculating GHGs balance and default values, performance standards for GHG threshold carried a risk of green protectionism. For suppliers and major biofuel exporting countries, the British and Dutch efforts to create GHG performance standards raised unique compliance concerns. The UK's acceptance of qualifying standards to meet sustainability criteria allowed biofuel suppliers to take advantage of existing certification programs. However, no such certification programs existed for GHG criteria.

Setting GHG thresholds would essentially undo the notion of 'like' biofuel commodities. Requiring firms to conduct GHG calculations on their PPMs to distinguish biofuel supply chains based on GHG balance would likely lead to trade discrimination for biofuels that did not perform well against national GHG thresholds. On the other hand, the Netherlands and the UK had small biofuel industries and therefore most biofuel consumption would be met by imports, undermining the argument that national requirements to meet GHG thresholds amounted to origin-based discrimination. Nevertheless, demonstrating the low-carbon value was essential to uphold the legitimacy of biofuel policies.

Both the UK and Dutch governments planned to implement GHG performance standards without limiting market access. In the UK, only those biofuels that met minimum sustainability and carbon savings performance requirements would be rewarded RTFO certificates. Biofuels

coming from supply chains with poor GHG performance would not count towards fuel suppliers' commitments to national renewable energy targets. For example, if sustainability performance standards discouraged the use of one kind of fertilizer over another to cultivate biomass for ethanol, ethanol producers in Brazil may experience discrimination.

However, questions remained regarding the threshold levels of GHG performance standards. Lower threshold values would benefit more bioenergy supply chains worldwide, creating more competition for foreign and domestic producers of conventional biofuel that already met the initial thresholds of 30% and 35% (Earley, 2009). However, setting higher thresholds could threaten certain producer groups. There appear to be only a small margin of GHG savings between European rapeseed biodiesel producers and producers of biodiesel from palm oil and soybean oil. Consequently, a threshold of 35% GHG savings would favor European rapeseed biodiesel. By contrast, a GHG threshold savings of either 30% or 40% would reduce discrimination for both domestic and foreign biodiesel producers by categorizing most producers either under or over the threshold. Biodiesel made from rapeseed in Canada and China and from foreign palm oil and soybean oil biodiesel producers would not meet these criteria. The Dutch threshold of 30% for liquid biofuels would also limit the import of US corn ethanol as traditionally produced.

Critics of GHG performance standards argued that GHG thresholds had been selected as much on the basis of European domestic producers' performance than on scientific consensus. As Erixon (2009:8) has argued, "from a legal point of view, the 35% criterion is chosen arbitrarily" and "effectively closes future market expansion for the main biodiesel competitors." Dutch advisors recommended other approaches, specifically concluding international agreements, supporting aspects of sustainable production financially, and transferring technology (Van den Bossche et al., 2007).

An internationally accepted methodology for calculating GHG baselines, balances, and default values for different biofuel commodity chains would help reduce the risk that GHG performance standards would spark trade disputes at the WTO on green protectionism. Like other transnational environmental and social performance standards, GHG standards would need to be based on an internationally accepted methodology. The British and Dutch groups identified key components of such methodology, which included a calculation category for the displacement effects on GHG emissions, namely the emissions associated with iLUC and co-products, even though both groups assumed that emission variables related to iLUC would likely not be substantial.

In the next section, I discuss how GHG modeling became a contested area of rule development in the emerging regime complex for biofuel sustainability. Both the Cramer Commission and the UK RFTO group agreed that the fair development of GHG thresholds required a body of experts with international representation with input from multiple stakeholder groups. There are a number of "codes of good practice" designed by the WTO, the International Standards Organization (ISO) and ISEAL to aid in the development of internationally accepted standards compliant with trade rules. Both the WTO and ISEAL codes require the proper identification and consultation with all parties that will be affected by the standards. To consult all the potentially affected parties affected by a global standard for the calculation of GHG

balance and default values would be time consuming. Given the diversity of biofuel value chains, the scope of consultations would need to cover many sectors and countries. The Cramer Commission noted that it would be especially desirable to include stakeholders from biomass producing countries (Cramer, 2006: 24). As shown in the case of the FSC and other commodity roundtables, properly developing a new standard through extensive stakeholder consultations could not be accomplished in a short time.

7.5 The politics of expertise in low-carbon value creation

Although the original call for biofuel sustainability standards implied a robust focus on environmental and socio-economic impacts, much of debate and deliberation over setting biofuel standards soon coalesced on the question of how to accurately quantify the GHGs emitted throughout the lifecycle of biofuels, taking into account that biofuels can be made from different kinds of crops. Regimes in the biofuels regime complex all adopted a division of labor that separated work on GHG calculations for low-carbon value from work on social and ecological criteria. To some extent, this reflected the political importance of quantifying GHGs emitted throughout the lifecycle of biofuels. It also reflected the Meta-Standard approach, in which many of the social and ecological criteria were already linked to existing standards.

As discussed in the previous section, European efforts to develop sustainability standards, specifically debates about how the displacement effects of biofuels would affect various other social and environmental impacts, drew attention to these the GHG estimates underlying many biofuel consumption mandates. Debate soon intensified over the validity of the methods and models used to calculate biofuel GHG emissions. A broad range of scholars, activists, industry lobbyists, governmental officials and IGO representatives weighed in on the question of how to measure and compare the lifecycle GHG emissions of various types of biofuels to petroleum fuels.

By most accounts, the mainstream policy actors supporting the 2003-2005 wave of biofuel targets in the US and Europe assumed all biofuels had good GHG implications and therefore represented a GHG offset (see, e.g., Bloomfield and Pearson, 2000).[177] Many governmental and non-governmental organizations had already devised rudimentary methods for estimating the volume of transportation-related GHG emissions averted by displacing gasoline with biofuels. In a 2006 analysis of major ethanol studies, the NRDC concluded that both corn and cellulosic ethanol production would outperform gasoline in terms of energy use from a life-cycle perspective (NRDC 2006). The following year, the US Environmental Protection Agency conducted a similar analysis to calculate GHG emissions for a variety ethanol feedstocks and conversion process combinations in conjunction with its final rules for implementing the original Renewable Fuel Standard under the Energy Policy Act of 2005 and 2007. These estimates provided important justifications for government mandates that increased national biofuel

[177] Depending on some variation in the energy intensity of feedstock cultivation, transport, processing, production and use, many estimates indicated ethanol from sugarcane was expected to provide 90 percent reduction in GHG compared to gasoline, whereas ethanol from annual root and cereal crops was estimated to provide between 10 to 15 percent reduction, and ethanol from corn and cellulosic biomass as estimated to fall somewhere in between. These are figures cited frequently in early research initiatives conducted by the RSB and OECD.

consumption and justified doing so on the basis of improved energy security, climate change mitigation, and national economic development.

In addition to the under-developed nature of GHG calculation methodologies for the biofuel sector, there is the separate issue of acquiring accurate default values for various stages of the chain. Using the traditional life cycle analysis (LCA) methodology of the ISO 14040 standard, net GHG emissions savings for biofuels are calculated by comparing the GHG reduction per unit fuel from producing and consuming biofuels with that of convention liquid fossil fuels from mineral oil, as well as the emissions related to reference land uses. This requires default values for the various component processes, resource uses, and co-products produced. Such default values must be accompanied with a methodology for how to render different kinds of emissions comparable for aggregation purposes, as well as a way to allocate emissions among different co-products made from the same process (e.g. ethanol and dried distillers grain and solubles).

Moreover, to incorporate land use into this equation, there must be reliable default values of GHG emissions for different land use categories. Arguably, the most reliable default values come from the Intergovernmental Panel on Climate Change (IPCC). The IPCC methodology has since become the most widely used protocol for calculating land use change related GHG emissions. But even these values are subject to great uncertainties.[178] Moreover, even though the IPCC data takes on the issue of indirect effects from LUC on carbon stocks, it does so with a different intention for using the "indirect" LUC variables.[179] In short, in order to separate the direct human-induced effects from indirect effects and natural disturbances in the implementation of the UNFCCC Kyoto Protocol's Clean Development Mechanism (CDM), the IPCC introduced very conservative baseline methodologies based historical changes in the carbon stocks to ensure that CDM projects would not earn credits for emissions avoided by the land use change from pastureland to forestland.[180] In addition, these default values are made more

[178] As Gutíerrez (2007) notes, in the IPCC Special Report, there is hardly a page that does not mention the word 'uncertainty.' The IPCC issued a standard methodology in 2006 for use by all countries around the world for reporting national GHG emissions to the United Nations Framework Convention on Climate Change (UNFCCC). This methodology calculates land use related GHG emissions, such as CO2 and N2O from soil, N2O from nutrients, based on default emission values provided by the IPCC. The IPCC also provides default emission values for fossil fuels. However, the default values for terrestrial carbon stocks have a very large variation between different ecosystems within the same category. For example carbon stocks in above ground forest vegetation can range from 164 tonnes C/ha for tropical rainforests in Asia to 56 tonnes C/ha for average European forests (IPCC, 2006). To apply such values to GHG calculations for a biofuel commodity chain like sugarcane ethanol would require choosing a geographically specific default value (e.g. Brazil or the United States) to set a regulatory threshold for Using the globalized average values provided in the methodology may thus result in significant errors (both positive or negative) in the results.

[179] The notion of indirect effects as it related to carbon stocks was introduced in the early 2000s to guide implementation of the UNFCCC Kyoto Protocol's Clean Development Mechanism (CDM). The CDM is designed to facilitate investment in emission reduction projects in developing countries by issuing emission reduction credits to developed countries with mitigation commitments under the UNFCCC. The Kyoto Protocol stipulates that in order to generate credits for land use activities classified as carbon sinks, emission reductions must be the result of "direct human-induced" action, as opposed to "indirect" human action.

[180] In its special report prepared on carbon sinks for the CDM implementation, the IPCC determined that terrestrial ecosystems sequester on average 2.2 GtC per year through natural regeneration, globally (Gutierrez, 2007). These carbon stocks constitute "indirect" effects because the IPCC considers them to be "natural" disturbances. Countries cannot receive CDM credits for such indirect, non-human induced, naturally occurring carbon and nitrogen stocks.

complex by the discount rate of indirect natural nitrogen deposition, atmospheric concentrations for carbon dioxide over time, or activities that took place before the reference year all require assumptions be made for which there is little data.

In this section, I look closely at how this debate unfolded in two US regulatory processes, one at the federal level and the other at the subnational level in California. Although the debate was by no means limited to these jurisdictions, the timing of these regulatory initiatives under the implementation of the US Renewable Fuel Standard was such that other jurisdictions watched closely to see how US policy developments unfolded.[181] The US has been a key site for conflict over whether consequential LCA models that consider ILUC should be used as regulatory technologies. In the US, instead of amending the volumetric targets for biofuel consumption (as did some European governments discussed above), federal and state governments devised ways to include ILUC in GHG standards. This was especially surprising given that many LCA experts considered ILUC to be "bad science." As this chapter aims to show, US debates about GHG modeling have had a wide spread impact throughout the biofuels regime complex.

Public regimes assumed a more influential position in the regime complex as sites of important technical debates over whether consequential or attributional LCA were appropriate for informing state-based biofuel standards. This is in large part due to the nature of biofuel policymaking: by implementing biofuel consumption mandates and subsequent regulations to ensure biofuels were a more sustainable and low-carbon fuel compared to gasoline, public regimes assumed a more influential position in the regime complex. Alongside the Food vs. Fuel controversy, governments had to confront a new epistemology that undermined previous studies depicting biofuels as having a favorable GHG impact. Studies that represented the consequential LCA epistemology showed significant GHG emissions resulting from ILUC that would occur when increased biofuel demand from government mandates was met by an expansion of global biofuel supplies.

Controversy over Indirect Land Use Change (ILUC)

Indirect land use change (iLUC) refers to the idea that diversion of an acre of traditional field cropland in the United States to grow a biofuels feedstock crop might result (due to market price effects) in that same acre reappearing at another location and potentially on virgin soils, such as the Amazon rainforest. Such a transfer—when included in the lifecycle GHG calculation of a particular biofuel—could result in an estimated net increase in GHG emissions.

To separate direct human-induced effects from indirect effects/natural disturbances, the IPCC introduced baseline methodologies based historical changes in the carbon stocks. Baselines are intentionally conservative to prevent new CDM projects from earning credits for avoided emissions from the displaced activity. For example, if a CDM project converted pastureland that had high cattle emissions to forestland without cattle emissions, the CDM project would not earn credits for any of the emissions that would be avoided by changing the land use from pasture to forestland, because the CDM aims to only reward emissions reduced by the change of activity (no more ranching) rather than emissions related to changes in the carbon stock baselines (which would not be considered to have avoided emissions, even though its carbon stock would increase as a forest verses pastureland). Another example would be rewarding credits for CDM projects that end the practice of deforestation from prescribed burns, despite the fact that fire-related deforestation can also occur via lightening. Thus distinguishing natural sinks from human-induced sinks is extremely complex.

[181] This is based on my own participation in RSB meetings and other policy conferences in California and Washington D.C.

The exact effects of land use change (LUC) and indirect land use change (iLUC) on the GHG-balance of a biofuel commodity chain are difficult to quantify, especially the effects of changes in below ground carbon stocks, and depend on assumptions such as the time frame considered. Moreover, LUC and iLUC are difficult to monitor. A key challenge in quantifying and monitoring LUC and iLUC is that data on carbon stocks are often incomplete or subject to too many assumptions to be reliable estimates.

The Food v. Fuel debate helped foreground the issue of indirect impacts, spotlighting earlier research on the impacts associated with relying on industrial agriculture for fuel production that had previously received little press. The logic that upward price trends in one commodity can indirectly cause an increase in price trends in another commodity was not a new idea. Furthermore, that the changes in consumption for one commodity can skew the consumption of other commodities is not a problem that is unique to biofuels. Yet controversy popularized the notion of land use change as a category of indirect impacts. This helped to expand the discourse used by traditional ethanol assessment studies focused on direct impacts. The main implication of the idea that biofuel production would tighten the availability of land used for food crops and livestock is that more land would have to be brought into production. Such land use changes presented numerous possibilities, as indicated in the range of claims made by critics like George Monbiot and advocates like Tom Daschle. Initially, reports from governments, academia, NGOs and IGOs expressed concern about land use change in terms of biodiversity.[182] The implications for climate change soon became clear as well. Monbiot (2007) captured the cognitive shift well in his column:

> A paper published in the journal Science three months ago suggests that protecting uncultivated land saves, over 30 years, between two and nine times the carbon emissions you might avoid by ploughing it and planting biofuels. Last year the research group LMC International estimated that if the British and European target of a 5% contribution from biofuels were to be adopted by the rest of the world, the global acreage of cultivated land would expand by 15%. That means the end of most tropical forests. It might also cause runaway climate change.

Soon, the idea of iLUC became the focus of new research on ethanol's carbon cycle. Previous research had focused on comparing carbon storage potential in competing land uses and on counting emissions resulting from the use of energy and chemical inputs, crop yields, the production processes at ethanol plants, and the energy expended to distribute ethanol at the pump and consume it in automobiles. New studies began to proliferate, questioning the prudence of biofuel support policies given that the potential CO2 savings from biofuels depends greatly on the use of inputs, crop yields, the energy intensity of transport and processing, and production efficiency (See e.g., Crutzen et al, 2007; Farrell et al. 2006).

New studies gave revealed more variation in GHG emissions, focusing greater attention on crop-specific effects. For example, biofuels made from corn and rapeseed would likely contribute to global warming because these plants have relatively poor nitrogen fertilizer uptake, resulting in more nitrous oxide (N2O) emissions than would occur from grasses or woody species (I.e. cellulosic biomass) (Crutzen et al., 2007). Others expressed concern about the potential for corn ethanol, sugarcane ethanol and palm oil biodiesel to drive land use changes.

[182] For example, see Hutton (2010).

Converting rainforests, peatlands, savannas, or grasslands to agricultural land for biofuel production or for displaced agricultural production (resulting from biofuel production) could harm biodiversity and sensitive ecological areas. Such land-use changes could release more CO2 into the atmosphere than would be saved from displacing gasoline with ethanol (Fargione et al., 2008; Searchinger et al., 2008). While corn ethanol began to look more and more unattractive from an ecological perspective, similar studies showed sugarcane ethanol would reduce GHG emissions significantly relative to petroleum gasoline (Wang et al., 2007; 2008). These findings ignited technical debates about the validity of the methods used to quantify lifecycle GHGs.

These studies prompted governments to look more closely at the issue. US governmental responses are discussed in detail below, but European governments also took the issue seriously. For example, the UK government commissioned a review of the studies in 2008 to examine the validity of the results generated by consequential LCAs. The review panel, now known as the "Gallagher Review," concluded that there is a future for a "sustainable" biofuels industry but that significant risks of ILUC exist (UK RFA, 2008). The UK amended its renewable fuel target but stopped short of a moratorium arguing that a biofuel market should be encouraged in order to ensure sustainable innovation in biofuels continues. In the Netherlands, the Cramer Commission identified key components to be considered for a GHG accounting methodology including displacement effects, namely emissions associated from iLUC and co-products. The Cramer Commission originally focused on iLUC in terms of biodiversity; iLUC caused by biofuels could lead to the deterioration of biodiversity elsewhere, which could in turn contribute to a negative CO2 balance for example in the event that forests are cleared to create land for agricultural commodities that have been displaced by biomass cultivation for the biofuels market. However, in developing their GHG calculation tools, both the UK and the Netherlands proceeded by setting aside consideration for emission variables related to land use change in GHG calculators until clearer understanding of how to use such variables emerged at a later date

Another approach developed by the German government was to include a penalty in GHG calculators for agricultural activities that pose a risk of carbon stock destruction. Including criteria for the conservation of carbon stocks is one alternative approach that could be used in lieu of including LUC or iLUC in GHG models. In order to prevent carbon stock destruction in the agricultural sector, several studies emphasized the need to reduce the pressure on using marginal lands to grow biofuel feedstocks (Dufey, 2007; Fargione et al., 2008; Kløverpris et al., 2008; Pagel 2008). Several authors have indicated the large potential of energy crops on degraded land but definitions range for what constitutes degraded (Dehue et al., 2006, Diemont 2001, Hoogwijk 2003, Lal 2006). Conversely, it was also possible that demand for displaced crops would decrease, or that demand would be met through another commodity or technology. This raised the question of how to account for by-products, an issue that further complicated the development of better GHG accounting models.

Epistemic Debates over Life-cycle Assessments for Biofuels in the United States

Two coalitions of epistemic communities emerged with different positions on whether and how to count emissions resulting from unwanted displacement effects of increased biofuel production. Debates centered on how to create a lifecycle accounting method that would properly

calculate carbon emissions, given emissions from indirect land use change (iLUC), by-product allocations, limited data sources, and choices about which values to use for input variables like "years of allocation"—all of which are factors that can significantly impact whether a particular biofuel chain releases less carbon into the atmosphere compared to gasoline. Lack a scientific consensus on how to properly count carbon, regimes developed different lifecycle assessment methodologies.

In the US, early estimates of GHG emissions of biofuels compared to gasoline used a life-cycle analysis (LCA) model referred to as "GREET" (Greenhouse gases, Regulated Emissions and Energy in Transportation).[183] GREET was developed by the US Argonne National Laboratory and used in previous studies on ethanol for the US Department of Energy. DOE studies using the 'GREET' model estimated that the use of conventional corn ethanol resulted in 20 percent less lifecycle GHG emissions compared to gasoline. NRDC and EPA also concluded that the reduction in lifecycle GHG emissions from corn ethanol could be as high as 70% if ethanol is produced at a dry-mill ethanol plant that sources corn from a no-till farm, utilizes corn stover as an energy source to power the plant, and captures and sequesters carbon dioxide from the plant's fermentation tanks for geologic sequestration — practices that are not yet commonplace in US biofuel production. Cellulosic ethanol was estimated to have even greater GHG reductions. Results generated by GREET consistently supported ethanol as a low-carbon fuel source compared to other alternatives. These analyses supported an expansion of biofuels production in the RFS as proposed by the Energy Independence and Security Act (EISA) of 2007, which raised the US target for renewable fuel production to 36 billion gallons of biofuel by 2022 and created the categories shown in Table 2 above.

The conclusions drawn from GREET were heavily criticized by researchers from Iowa State, the University of Minnesota, the University of California-Berkeley, and a number of NGOs including Clean Air Task Force, Environmental Working Group, and Friends of the Earth (see, e.g., Farrell and O'Hare, 2008; Searchinger et al., 2008; Searchinger and Heimlich, et al. 2008; Fargione et al. 2008). In published studies and research letters, technical experts pointed out that studies using GREET did not account for the indirect impacts of biofuel production.

Among these, a study by Tim Searching et al. published in Science Express in February 2008 received the most attention. Whereas the EPA had found that corn-based ethanol gave a 20 percent reduction in GHG emissions compared to gasoline, Searchinger et al. (2008) found that ethanol made from corn and switchgrass would increase GHG emissions by 93% and 50%, respectively, compared to gasoline over the same time period. Using a set of partial equilibrium and non-spatial econometric models developed at the Center for Agricultural and Rural Development (CARD) of Iowa State University and the Food and Agricultural Policy Research Institute (FAPRI) at the University of Missouri, Searchinger et al. argued that a spike in US ethanol consumption diverts US grown corn away from food markets, which causes producers around the world to plant new crops to make-up for the shortfall of grain products for non-ethanol markets. New crop plantings ultimately lead to expansion of cropland, which results in habitat destruction (e.g. deforestation). Such 'land use change' results in significant GHG emissions (CO2 equivalent) because carbon sequestered in vegetation and soil are released when new land is brought into agricultural production. Because producing corn for biofuels causes

[183] Both the EPA and NRDC mentioned in the previous paragraphs used GREET.

indirect land use change (ILUC), Searchinger et al. (2008) concluded that the lifecycle GHG emissions for corn ethanol are significant enough to produce a carbon "debt" that would take 160 years to pay back using the CO2 absorbed by crops grown for biofuels.

Studies advocating for the inclusion of ILUC in GHG models for biofuels sparked an intense debate among experts about the proper analytical boundaries for life-cycle assessment. Ultimately, pro-ILUC actors were supporting a relatively new kind of epistemology for calculating lifecycle GHG emissions, which took into account indirect impacts. They argued that although "consequential" LCA models were new and undergoing refinement, they could nevertheless complement the more traditional "attributional" LCA models, like GREET. Attributional LCA is the classic model used to describe the resource and pollutant flows of a particular product at a predetermined scale in a static production system. Often referred to as an "accounting LCA" or a "process-based LCA," attributional LCA procedures have been standardized by the ISO 14000 environmental management standards. By contrast, the consequential LCA is conceptually more complex, relatively new and without a standardized methodology of attributional LCA.

By contrast, consequential LCA models attempt to measure impacts in situations where some decision causes a change in output of the functional unit (e.g. increasing biofuel consumption), instead of aggregating inventories of resource and pollutant flows at various points in a product's life cycle. Whereas an attributional LCA uses the averages of data representing various points in the resource and pollutant flow, a consequential LCA relies upon marginal data representing things like marginal production costs, supply/demand elasticity, and other changes in the output of goods/services. Those impact categories that are not disturbed by the change in output being studied are not included. Therefore a number of assumptions are embedded in consequential LCAs, which affect where analytical boundaries are drawn. Moreover the results obtained from consequential LCAs are highly dependent on the assumptions made by the researcher.

Sub-national ILUC controversy at California Air Resources Board (CARB)

The California Air Resources Board (CARB) decided carbon intensity calculations in the LCFS must include indirect emissions from land-use change. The US corn-ethanol industry attacked this decision arguing that ILUC would make it difficult to sell grain-based ethanol in California and therefore CARB was unfairly penalizing corn ethanol producers using unproven science (See e.g., New Fuels Alliance, 2008). The academic and government research community appeared split.[184] But in March 2009, CARB released its proposed regulations for reducing transportation emissions under the California Low Carbon Fuel Standard (LCFS). With the help of researchers from University of California-Berkeley and Purdue University, CARB introduced a consequential LCA model that inputted the emission rates used by Searchinger et al. (2008) into Purdue's Global Trade Analysis Project (GTAP) — a global computable general

[184] In a letter to CARB, a group of 27 researchers from US universities and national laboratories argued that there was not enough hard empirical data on which the LCSF could evaluate indirect impacts of renewable biofuels production (Simmons et al., 2008). However, a year later 170 scientists and economists urged CARB to account for GHG emissions from indirect land use change for all transportation fuels (including biofuels), arguing that despite the uncertainties, the science did not warrant "assigning a value of zero" (Simmons et al., 2008).

equilibrium model traditionally used by economists to estimate how an economy might react to changes in policy, technology or other external factors.

The results generated by CARB's consequential LCA model, as referred to as the California-GREET (CA-GREET), showed the carbon intensity of corn-based ethanol to be greater than the carbon intensity for gasoline (99.40 grams CO2 per mega joule of energy generated (g CO2/MJ) and to 95.86 g CO2/MJ respectively). However, the carbon intensity of sugarcane ethanol was found to be less than that for gasoline (73.40 gCO2/MJ). Among the CO2 emissions that could be attributed to ILUC, corn had 30 percent whereas gasoline had none, thereby supporting the idea that increasing corn ethanol production in the US would displace crop production to the point where displaced crops would have to be grown in other countries on land previously untouched by agriculture. Under the LCFS, gasoline refiners would reference the carbon intensity of corn ethanol and sugarcane ethanol when deciding which low-carbon fuels to purchase to meet their obligations reduce carbon in the fuel they sell to consumers.

Faced with a state regulatory technology (the CA-GREET) that would disadvantage corn ethanol producers, the ethanol industry joined forces with the petroleum and corn industry associations to attempt to stop implementation of the LCFS. In December 2009, the major US corn ethanol associations Growth Energy and the Renewable Fuels Association joined by the National Petrochemical & Refiners Association and other organizations filed a suit in U.S. District Court in California asking the federal court to declare California's LCFC unconstitutional and injurious to the domestic ethanol industry.

The Renewable Fuel Association also commissioned its own analysis of CARB's consequential LCA (RFA, 2010), which integrated recent updates to the model made by Tyner (2010), an agricultural economist at Purdue. The results showed that CARB's overestimated GHG emissions from ILUC for corn ethanol by a factor of two in developing the proposed LCFS. This vastly improved carbon intensity rating was due to Tyner et al.'s (2010) inclusion of new data into GTAP, including more current economic data, cropland pasture data, valuation of distillers dried grains (a key co-product of ethanol), and estimated crop yields. In 2010, the RFA successfully convinced CARB to reevaluate its modeling in light of Tyner et al.'s updates to the GTAP model, which will prove more favorable to corn ethanol producers by cutting CARB's original estimation of ILUC emissions by half.

In the meantime, CARB continued to make adjustments to the LCFS to incorporate new information into the models towards finalizing the model 2011. In revised models, the ILUC values in CARB models were significantly lower. The CARB Expert Working Group warned that the GTAP model was not as accurate a partial equilibrium models compared to the FAPRI model used by Searchinger, et al. (2008). While general equilibrium models cover the global economy (disaggregated into diverse sectors, regions and countries and include labor market values), partial equilibrium models focus on agricultural sectors only and can allow for a more detailed representation of agricultural land use. In 2012, the court presiding over the suit brought by Growth Energy and other industry actors ruled that the LCFS was unconstitutional. The case continues to be fought in 2017, with the plaintiffs' most recent arguments focused on dormant UC Commerce Clause and the discriminatory effect of the LCFS on Midwestern competitors.

National ILUC controversy at Environmental Protection Agency (EPA)

The EPA also chose to integrate ILUC into its GHG standards for biofuels. Under the 2007 Energy Independence and Security Act, (EISA) the EPA was ordered to create a method for calculating the lifecycle GHG emissions so that biofuels could be categorized according to their GHG emission thresholds, as shown in Table 2 above. By specifying the minimum amount of lifecycle GHG emission reductions associated with each category of biofuel and setting annual volumetric targets that would progressively favor biofuels with higher emission reductions, EISA aimed to ensure that at the very least, all biofuels qualifying for renewable certificates under the RFS would be less GHG-intensive than fossil fuels.

In May 2009, just months after CARB released its proposed ruling, the EPA released its proposed method for calculating lifecycle GHG emissions for biofuels and gasoline and diesel fuels for public comment. Like CARB, the EPA included ILUC emissions and found that many fuel pathways did not meet the threshold requirements stipulated in the EISA. Despite CARB's desire to compliment the RFS2, the EPA chose to rely on different models and assumptions, for example by assigning existing ethanol refineries higher efficiency values than CARB had.

Second, the EPA coupled two partial equilibrium models to build a consequential LCA model similar to that used by Searchinger et al. (2008). The EPA combined its original GREET model with the FAPRI and FASOM models developed by University of Missouri and Texas A&M University respectively (both peer-reviewed economic models of the domestic and international agricultural sectors) and satellite data to predict the type of land worldwide that may be converted into cropland under biofuel expansion scenarios (e.g. Brining new land into agricultural production, e.g. rainforest, savannah, degraded land). The results indicated that GHG emissions from ILUC for corn ethanol are very high, whereas the ILUC emissions for biofuels from sugarcane, cellulosic and waste materials are very low. However, unlike Searchinger, the EPA found that a much shorter amount of time would be required to "pay back" the GHG emissions from ILUC. Two timeframes were considered, each of which resulted in drastically different outcomes. Assuming a 100-year timeframe and using a two percent discount rate of the GHG emission impacts corn ethanol production in a basic dry mill facility, the EPA calculated the GHG emissions reduction of corn ethanol to be 16 percent less than the 2005 gasoline baseline. By contrast, using a 30-year timeframe with no discounting, EPA calculated the GHG emissions reduction of corn ethanol to be 5 percent more than the 2005 gasoline baseline. EPA decided to base its regulations on the 100-year scenario, which allowed for a calculation methodology that was more favorable to ethanol made from domestically produced corn.

The industry has continued to fight ILUC at the federal level, reminding the agency that earlier DOE studies using the 'GREET' model estimated that the use of conventional corn ethanol resulted in 20 percent less lifecycle GHG emissions compared to gasoline. Because the GHG reduction threshold for corn ethanol under EISA was previously set at 20 percent (before the agency had released its estimate), the ethanol industry was threatened by the conclusion that corn ethanol reduces lifecycle GHGs by only 16 percent. Domestic ethanol producers criticized the EPA methodology, continuing to point to data released by the Department of Energy showing current ILUC for corn ethanol has turned out to be minimal to zero. The industry argued that the proposed rule would hinder development of the biofuel industry. US ethanol producer

associations such as Growth Energy, the Renewable Fuels Association (RFA) and the National Corn Growers began a campaign attacking the scientific validity of consequential LCA. A central claim was the economic modeling used in CLCA is notoriously inaccurate especially when used for forecasting purposes. ILUC involves uncertain assumptions about yield increases, the area and types of new land that are brought into agricultural production, and the decision-making of other governments and farmers (de Gorter and Just, 2010). They also questioned why indirect GHG emissions were not considered when calculating the 2005 baseline for petroleum fuel, and why ILUC was not factored into policies for other agricultural crops.

In response, the EPA asked four independent peer review panels comprised technical experts mostly of academics, including Timothy Searchinger, to assess the EPA approach to measuring the lifecycle GHGs of different types of biofuels. After examining the overall modeling approach, timeframe chosen for analysis, the use of satellite imagery to determine changing land-use trends, and the emission factors used for international agriculture, all of the reviewers found ILUC to be an important impact category. The majority of reviewers endorsed the EPA's modeling approach and supported that the coupling of two partial equilibrium models to create a consequential LCA. They also agreed that using satellite imagery to predict land-use change patterns agreed was a scientifically valid approach and that the EPA had used the best available data international agriculture emissions.

However, some experts remained concerned that the EPA's models were not ready to be used in regulations. Although they agreed that the EPA was using the best available tools and approaches for assessing ILUC, they pointed to the need for scientific validation of the EPA's timeline, improvements in future assessments of land use change patterns by validating satellite imagery against local and regional knowledge, and greater transparency in the overall modeling process. To address the methodological and data limitations of consequential LCA, experts recommended future research to develop a standard methodology to identify which indirect effects should be included in consequential LCA. This would require constructing a framework that systematically characterizes and manages uncertainties and establishes common protocols regarding transparency. Also, more investigation would be needed to understand how to best integrate multiple economic and geophysical models into LCAs. It was recommended that policy makers explore additional policy measures to ensure that biofuel policies will lead to mitigation of GHG emissions and improvement of sustainability.

Nevertheless, the EPA moved forward. In the final RFS2 issued in March 2010 the agency determined that corn ethanol provides a 21% GHG advantage over conventional gasoline, despite the conclusion in 2009 that corn ethanol would only have a 16% reduction in lifecycle GHG emissions. As a result, all corn ethanol (both grandfathered production and new production) is eligible to qualify for the RFS2 program under the conventional biofuels category. EPA Administrator Lisa Jackson provided some insight into the decision, explaining, "Corn-based ethanol is a bridge to the next generation of biofuels." The EPA reasoned that because corn yields are expected to improve, domestic land use change and ILUC would not be as significant as previously thought. In addition, the EPA asserted that corn exports will not be reduced by corn ethanol because dried distillers' grains (DDGS), a co-product of the ethanol production process, would provide adequate volumes of livestock feed, thereby compensating for the need to grow more corn and soybean meal abroad. Some biofuels critics argue that the final

rule conceded too much; in most cases, estimated emissions decreased and emission reductions increased, leading to more favorable treatment of biofuels in the final rule.

This appeased corn ethanol producers to some extent, but they continue to contest the inclusion of ILUC as unfair and scientifically unjust. The RFA argues that new science on quantifying GHG savings is constantly changing, as indicated by recent studies that find improvements in agricultural yields and operational efficiency at ethanol plants. In addition, they point to the variation in modeling approaches, key assumptions, inputs and results to highlight a lack of scientific consensus on calculating land use. While Searchinger and others originally estimated the corn ethanol LUC impact at 103 g/MJ, CARB estimated 30 g/MJ for the average of seven scenarios for its final LCFS rule. Meanwhile, the US Renewable Fuel Standard proposed rule was based on the EPA's estimation of 63 g/MJ, while the EPA's final rule estimated LUC emissions at 28 g/MJ. In addition, a paper by Purdue researchers utilizing an improved version of the GTAP model estimates an LUC value of 14 g/MJ. The latest Purdue results are for a scenario that projects 1% crop yield growth to 2015 as well as growth in the demand for food between 2007 and 2015. (RFA et al., 2010)

Producer responses to the ILUC debate

The EPA and CARB approaches to ILUC modeling also have significant implications for ethanol producers. Brazil is the second largest ethanol producer country after the US, and exports a substantial amount of ethanol to the US and European countries. Because of the high efficiency of Brazilian ethanol plants, sugarcane ethanol has fared better than corn ethanol in terms of lifecycle GHG reductions. Under the RFS, sugarcane ethanol qualifies as an advanced biofuel, and under the LCFS in California, fuel providers can comply with LCFS simply by using sugarcane ethanol instead of corn ethanol.[185] Thus, although US tariffs on Brazilian ethanol protect domestic producers, the LCFS and RFS encourage greater Brazilian ethanol consumption even at high prices.

The ILUC debate has also impacted Brazilian policy. In 2009, the Brazilian government introduced agro-ecological zoning laws in 2009 to assuage fears that expanded sugarcane production is causing Amazon deforestation. These zoning laws exclude the Amazon Rainforest and Pantanal from sugarcane expansion. In 2010, Brazilian President Luiz Inácio Lula da Silva announced that deforestation in the Brazilian Amazon was at its lowest since 1988, when the government began collecting data on deforestation. Brazilian zoning laws may have also indirectly helped corn ethanol producers in the US: The EPA's proposed rule in 2009 assumed that U.S. corn ethanol triggered ILUC impacts such as the displacement of pastureland in Brazil, which in turn caused deforestation in the Amazon rainforest, but in its final rule the EPA reversed this position based on evidence from more precise satellite imagery that indicated land use changes in Brazil are not occurring as predicted.

However environmental groups countered that the agro-ecological zoning laws have only distorted data on emissions from direct and indirect land use change. Zoning has re-directed sugarcane expansion to the Cerrado and Pantanal—two largely uncultivated biomes with high

[185] The Brazilian sugarcane ethanol producers association, UNICA, submitted an *amicus curiae* brief defending California's LCFS against the charges brought by Growth Energy, et al. in 2010.

levels of biodiversity—as designated areas that are suitable for sugarcane expansion. The Cerrado is now disappearing twice as fast as the Amazon rainforest, as farmers and ranchers expand operations into this biome. Moreover, research indicates although relatively little forest land will be directly converted for biofuel production, large swathes of rainforest and Cerrado are still likely to be indirectly impacted through displacement of cattle ranching, presently the dominant form of land use in the Brazilian Amazon.[186]

While the US incorporated new information on ILUC into their existing biofuel policies, the European Commission (EC) chose a different approach by postponing a decision on direct and indirect LUC. When the EC published its long-awaited implementation guidelines for the EU biofuels sustainability scheme in June 2010, it added progressive GHG emission reduction targets. In addition to retaining the requirement from the original draft RED that qualifying biofuels should save 35% in GHG emissions, it also stipulated that this would rise to 50% by 2017 and to 60% by 2018. The Joint Research Center (JRC) of the EC conducted a more extensive review of the available models for studying ILUC from increased biofuels demand than the EPA or CARB (Edwards et al., 2010).

The JRC report proposed a new methodology to measuring ILUC and other impact categories using spatial data and processing techniques that provide more detailed estimates of GHG emissions. Unlike the RFS or LCFS, this approach combines quantitative and non-quantitative measures to tackle the ILUC problem. However, the JRC report authors recommended a detailed uncertainty analysis be undertaken in order to in order to understand how robust their model results will be (Edwards, et al., 2010).

The industry may have appeared satisfied with the Commission's decision to not include ILUC in its first version of sustainability criteria, but many international producers criticized the EC approach as inconsistent with approaches of some of its member states like Germany and Austria, which were the first to fully transpose the EC's sustainability criteria into national law, and member states that are still in the process of writing legislation. Producers also complained that until the EC formally confirmed that national laws comply with RED, producers would be subjected to an uncertain legal environment in which they have little guidance on whether to follow national laws. The EC generally dismissed these complaints, countering that producers can simply report impacts on a voluntary basis until national laws are completed.

The EU has also been heavily criticized by environmental groups, such as BirdLife Europe, the European Environmental Bureau (EEB) and Transport & Environment (T&E) for not factoring ILUC emissions into the meta-standard. In addition, environmental NGOs points out that EC-RED does not set any criteria for non-environmental impacts. However, unlike other governmental initiatives, the EC is responsible for monitoring and submitting reports every two years that discuss the impact of EU biofuel policy on food prices and availability—particularly for people in less-developed countries—land rights, labor rights, and ILUC. The reports are meant to inform the EC on the need for any future corrective actions to biofuel policies.

International initiatives responded to debates about ILUC in the US. By contrast, at the end of 2009, the RSB decided to integrate ILUC into its criteria and standards and created an

[186] See for example, Jepson et al. (2010).

expert task force on indirect impacts that worked closely with its task force on GHG emissions. After almost a year of discussions regarding the design of its own ILUC criteria, the RSB decided in 2010 not to include an ILUC factor due to the complexities and uncertainties surrounding the process of conducting a consequential LCA. The group also indicated that the emphasis on quantitatively assessing indirect impacts be balanced by qualitative assessment such as case studies and pilots—a similar approach to the one proposed by the JRC. Version 2 of the RSB Compliance Indicators issued in January 2011 included a minimum GHG reduction thresholds designed to allow a safety margin for ILUC. The RSB Criteria 3 required that the lifecycle GHG emissions of biofuel blends to be on average 50 percent lower than the gasoline, diesel, and jet fuel baseline, and that emissions starting at 50%, shall increase over time. The RSB has continued to work to be an information platform for indirect impacts that periodically revises its approach to reflect current the current state of knowledge.[187]

The GBEP and the International Organization for Standardization (ISO) announced it would create a new international sustainability certification program for bioenergy entitled "Sustainability for Bioenergy ISO 13065." The GBEP chose to avoid performing technical work on direct and indirect land use change, and positioned itself instead to facilitate international debate and share information. After requests to ISO from a number of countries including the Netherlands, the US, Sweden, Brazil, and the UK, a project committee (ISO/PC 248) formed to bring together a group of international experts to work to identify criteria and indicators on social, environmental and economic impacts by the end of 2012. At the launch, 29 countries were involved with Brazil and Germany providing leadership and hosting the secretariat. The United States and China are participating as observers but will not be involved in voting processes. Given ISO created the first international standard for attributional LCA (as part of the ISO 14000 environmental management standards), the project committee for bioenergy sustainability will likely examine the issue of modeling GHG emissions through attributional and consequential LCA in depth.

In conclusion, although different regimes have proposed different approaches to modeling lifecycle GHG emissions for biofuel commodity chains, normative consensus has emerged around the legitimacy of iLUC. Still, the question of how to count carbon remains as complex and significant as ever. Even the IPCC has been unable to advise on methodology for determining ILUC vs direct LUC (Kohler et al., 2012).

The events described in this chapter indicate a larger conceptual shift away from climate governance epistemologies based on a singular view of the atmosphere in which where emission reductions occur is of less concern than the aggregate reductions, towards a multi-sited view of emissions reductions that is based on the geography of carbon stocks. These methodologies will have a major impact on the way carbon is valued in other sectors and will shape climate policy more generally. They also have material consequences for the economic geography of biofuel development.

[187] In 2010, there was some discussion about simplifying the proposed criteria for indirect risk assessment to establish a definition for "low-risk biofuels" that have a relatively low amount of GHG lifecycle emissions.

Chapter 8 Towards a theory of coordination in regime complexes

What does the biofuels case reveal about coordination of multiple activities and institutions in a regime complex? In this chapter, I reflect on how experimentalist governance architectures and the process of evolutionary learning enable experts to orchestrate rule inconsistencies in a regime complex. First, I review scholarly debates regarding fragmentation, coordination and orchestration in regime complexes. I then examine how these dynamics have played out in the climate change, forestry and biofuel regime complexes. I conclude with an examination of the biofuels case.

Regime complex scholars are concerned with the causes and effects of fragmentation, as well as with understanding how fragmentation can be managed in regime complexes (Biermann et al., 2009). Fragmentation results from the proliferation of regimes functioning within different jurisdictional levels, across different scales, under different forms of authority, with different sets of actors. A regime complex connects regimes by the broad issue area that they seek to impact, but fragmentation makes regime complexes different from other transnational governance arrangements involving multiple regimes. It is also what threatens to degrade the long-term efficacy of the regime complex as a governance arrangement (Keohane and Victor, 2011).

Most individual regimes form independently, from the bottom up, by groups of actors focused on one particular approach to collective problem solving. Typically, the proliferation of transnational regimes is not coordinated (Brunsson and Jacobsson, 2000). The resulting network of overlapping and loosely coupled actors and rules is dense and decentralized. Proliferation without structural hierarchy leads to fragmentation and inconsistencies between regimes (Keohane and Victor 2011; Alter and Meunier, 2009). When organizations introduce new rules, or make changes to existing ones, they may conflict with other rules already at play in one or more components of the regime complex (Victor and Raustiala, 2004; Alter and Meunier, 2009; Bulkeley and Newell, 2011). A regime complex lacks a single "synoptic designer" to prevent this from happening (Ansell, 2011, p. 51).

Fragmentation allows powerful actors to "forum shop" instead of resolving disagreements over rule inconsistencies. Some actors may intentionally create rule inconsistencies as a strategy of "regime-shifting" to avoid unfavorable regulation (Murphy and Kellow, 2013). Industry actors may opt to develop self-regulation that competes with the regimes they disagreed with, triggering a race-to-the-bottom" (Keohane and Victor 2011). Instead of attempting to reconcile conflicting rules, important stakeholders may pursue the same regulatory agenda elsewhere, or simply abandon the larger governance project altogether. This in turn can encourage weakly defined rules.

When multiple private regimes compete for support, each individual regime may progressively lower its standards in order to attract firms. For example, in their study of the regime complex for plant genetic resources, Raustiala and Victor (2004) found that negotiators of a certain regime compensated for the lack of coordination with parallel regimes by adopting

overly broad rules in order to accommodate multiple interpretations and avoid conflicts with other sets of rules. However, sometimes differences over rule inconsistencies lead to innovation instead of gridlock. For instance, when industry groups began competing with the Forest Stewardship Council (FSC), FSC-supporters pressured industry regimes to innovate, thereby ratcheting up standards and procedures for the entire field of forest certification (see Chapter 6).

How then, do conflicts between regimes and rule inconsistencies get resolved in a regime complex? Much of the answer depends on the architectural features of a regime complex.

Regimes can be linked together by shared institutions or programs, which provide opportunities to align rules and coordinate action between regimes. Or, they may lack any substantive links at all. For example, parallel regimes may target the same behavioral outcomes using similar strategies but share no direct substantive overlap. In this case, both regimes have authority over an issue without being mutually exclusive or subsidiary to each other (Alter and Meunier, 2009).

There are also nested regimes, which overlap each other like Russian dolls; one institution occupies a position of hierarchical authority in relation to others and may be able to resolve rule conflicts (Aggarwal and Morrison, 1998; Alter and Meunier, 2009). For example, a nested regime like the WTO and regional trade agreements have mechanisms in place to resolve inconsistencies between conflicting rules. Nested regimes also evoke the kind of coordination Schouten (2013) describes in "meta-governance" arrangements for sustainable agriculture (p. 139). Actors from either the public or the private spheres may assume a more prominent position in regulating sustainable agriculture relative to other actors by exerting leadership over the harmonization of different certifying arrangements. Such orchestrators exist in parallel with other organizations without hindering them (140). Schouten points to the UN Forum on Sustainability Standards (UNFSS) as an orchestrator that aims to make private sustainability standards a driver for sustainable agricultural development in developing countries, instead of an obstacle for smallholders interested in selling into international markets. Its position as a UN program that is open to participation from all UN member states, and that is governed by a steering committee comprised of representatives from five UN agencies, gives it the ability to participate across multiple levels of governance.[188] Schouten points to ISEAL as another meta-governance orchestrator, albeit from the private sphere. The ISEAL alliance accepts members who comply with the ISEAL Code of Good Practice, which requires a commitment to the principles of inclusion, transparency, accountability in decision-making processes, and assurance mechanisms. Although the focus here is on procedural rather than substantive sustainability issues, ISEAL aims to encourage private governance arrangements to adopt a similar standard of operation as part of a broader strategy of improving the legitimacy of private governance regimes.[189]

[188] The UNFSS steering committee consists of five UN agencies: the Food and Agriculture Organization (FAO), the UN Conference on Trade and Development (UNCTAD), the UN Environment Programme (UNEP), the UN Industrial Development Organization (UNIDO), and the International Trade Centre (ITC).

[189] As Schouten (2013) notes, these meta-governance approaches have a number of strengths and weaknesses as governance systems for sustainable agriculture. For some, these regimes represent favorable strategies for overcoming some of the problems associated with private governance. For others, they are a source of tension in how regulatory power is distributed between producing and consuming countries and how such power impacts development strategies in the Global South.

As we saw in Chapter 7, here are also parallel, nested regimes that achieve coordination through experimentalist architectures. The FSC's international body oversees a network of smaller, more local certification institutions that seek approval from it in order to obtain licenses to operate. The EU FLEGT initiative, by virtue of its multilevel experimentalist architecture, can theoretically drive harmonization using "voluntary partnership agreements" (VPAs) as a coordination mechanism. This nested arrangement allows the EU to employ the mechanisms of monitoring, benchmarking and peer review to steer partner countries' forest legality verification policies in the same direction through negotiations of the FLEGT "voluntary partnership agreements" (VPAs). However, further research on VPA negotiations with partner countries is needed to understand the degree to which EU representatives compel partner countries to develop particular policies. As proposed by Overdevest and Zeitlin (2012), these regimes' experimental structures constitute a built-in coordination mechanism, through which a centralized decision-making body oversees some set of minimum substantive and procedural standards to be implemented by lower-level units—in this case the FSC satellite units and the FLEGT partner countries.

As shown in Chapter 7, although these public and private forest governance regimes operate in parallel and autonomously from one another, there is potential for coordination between them. As parallel regimes, the FSC and EU FLEGT operate without being either mutually exclusive or subsidiary to one another. Neither the FSC nor the FLEGT can compel compliance from the other in the face of rule differences. But they may reinforce or influence the other in certain situations. For example, public regimes for legality verification have nested private certification into their compliance structure. For timber operators that lack a FLEGT or CITIES permit, the FSC and PEFC are considered the best strategy for developing countries to build EUTR-compliant systems. In addition, the FSC, SFI and other industry programs have pride of place as compliance mechanisms under the US's Lacey Due Care Standard. These examples suggest that coordination can occur between otherwise autonomous public and private regimes for forest governance.

In addition, as Overdevest and Zeitlin (2012) argue, experimentalism can provide a coordinating mechanism between public and private regimes that operate in parallel. In theory, if there exists some kind of "shared learning platform" that extends between both nested regimes, a shared learning platform can enable inter-regime peer review as a coordinating mechanism. Yet, within the field of private forest certification, there is no single regime or combination of regimes that serve as a field-wide clearinghouse that monitors, benchmarks, or peer-reviews for the entire regime complex. The FLEGT and private certification programs require that audit reports are made publicly available. This shows that although regimes differ in how they enforce this requirement, broader publics have access to information that allows them to track and evaluate the performance of regulated entities.

Orchestration

A number of scholars show there are alternatives to hierarchal authority that often go overlooked by more traditional approaches to studying regime complexes. Much of the regime complex literature focuses on the causes, effects and degrees of fragmentation in a regime complex, as well as the narrow conceptualization of regime complexes as a set of public regimes

developed through legally binding, interstate agreements (Agarwal, 1998; Raustiala and Victor, 2004; Alter and Meunier, 2009). Scholars that map regime complexes to include not only public regimes, but also private ones led by non-state actors, have shown that orchestrators often facilitate coordination within a regime complex (Abbott and Snidal, 2009; Abbott et al, 2011). Orchestrators can reduce fragmentation and help to resolve conflicts and rule inconsistencies in regime complexes.

Orchestration is a non-hierarchical strategy similar to what Pattberg (2010) refers to as a "light coordination mechanism." Orchestrators can reduce fragmentation and help to resolve conflicts and rule inconsistencies in regime complexes.

In the climate change regime complex, international organizations (IOs) are well positioned as orchestrators. For example, most private carbon offset programs base their values on the standards established by the Clean Development Mechanism (CDM) in the Kyoto Protocol (Abbott and Snidal, 2009; Abbott 2011). Some carbon-offset programs go beyond the CDM standards to promote social or ecological co-benefits in emissions reductions (Estrada, Corbera and Brown, 2009). In this case, the UNFCCC/Kyoto Protocol/CDM represents an orchestrator that exerts some degree of coordination in the regime complex by virtue of setting standards that carbon offset programs consider to be the convention. Abbott (2011) considers this to be a weak form of coordination given that the UNFCCC cannot compel carbon-offset programs to adopt the programmatic norms of the CDM. This opens the possibility for forum shopping, especially with regard to how carbon-offset programs treat social and ecological criteria. Firms can forum-shop for the offset program best suited for poor environmental and social performance, which can create a competitive dynamic between offset programs. If programs with weaker standards attract more firms, a "race to the bottom" ensues.

By contrast Keohane and Victor (2011) suggest it will eventually be possible for the UNFCCC/Kyoto Protocol to act as strong orchestrator. Although they map the climate change regime complex as a narrow set of interstate relationships that lacks a unifying architecture, they predict that overtime it will be possible for the UNFCCC/Kyoto Protocol to assert a hierarchical structure that positions itself above other nested regimes. Until then, the authors expect rule inconsistencies to persist between regimes. Yet even if such architecture emerged, the regime complex would remain comprised of many private regimes, for which a nested architecture would be unlikely. Few if any private regimes are nested hierarchically, and most—like carbon offset programs—are only weakly linked to the UNFCCC/Kyoto Protocol/CDM or any other interstate institution (Pattberg 2010; Abbott, 2011). Thus, even a hierarchical authority would not be able to compel private regimes into compliance with public regimes.

International organizations (IOs) like UN agencies and programs are particularly well suited as orchestrators because they are positioned to catalyze new governance initiatives and harmonize behavior among the units that fall within their purview. For example, the United Nations Environmental Program's (UNEP) broad mandate is to "catalyze and coordinate" environmental action (GRI) (Abbott, 2011). Abbott (2011) points to IOs like UNEP and the World Bank as possible orchestrators of climate governance given their ability to lead the creation of clean development projects. In addition, IOs can use incentives and persuasion to build participation for certain initiatives. IOs can explicitly endorse certain standards or specific

regimes as more legitimate than others, which can prevent competition between regimes that spur a "race to the bottom," (Abbott 2011). For example, UNEP, the UN, and the World Summit on Sustainable Development endorsed the Global Reporting Initiative (GRI) as the gold standard for voluntary sustainability/transparency reporting (Abbott 2011). Pattberg (2010) suggests IOs may also orchestrate by acting as a clearinghouse that monitors the organizational structure and operations of private regimes. In this way, an IO may orchestrate simply by supporting experimentalist architectures, for example by ensuring information collected on competing regimes is available for peer review purposes and by interpreting performance data in ways that may help regimes improve performance.

The World Bank has also acted as an orchestrator in a number of regime complexes. In the forestry regime complex, World Bank has been instrumental in steering the development of public legality verification regimes and private forest certification standards, albeit separately. The World Bank FLEGT initiative helped catalyze timber verification laws in the US and Europe. In addition, the World Bank (alongside other powerful organizations with international purview like the FAO) endorsed the FSC over other forest certification programs (see Chapter 6.3), which helped to establish the FSC as a normative authority within the field of forest certification as the certification program with the most legitimate procedural standards. The WB has also used its authority to catalyze the Global Gas Flaring Reduction Partnership, which has been influential in the climate change regime complex (Pattberg, 2010).

National governments can also act as orchestrators. In the forestry regime complex, for example, some national governments have had to reconcile overlaps between their EUTR compliance and their commitment to sustainable forest management. EU FLEGT Voluntary Partnership Agreements (VPAs) do not require that definitions of legality include sustainability. As a result, what is considered legal timber harvesting in wood-exporting countries can allow socially or ecologically unsustainable forest management practices to go unabated, unintentionally encouraging unsustainable forestry practices. Some FLEGT VPAs have addressed this inconsistency by including requirements for sustainable forest management in their legality definitions or by explicitly encouraging private forest certification as a compliance step. For example, in the EU-Ghana VPA, the Ghanian government stipulated it would modify its legality definition in five years to increase incentives for communities and landowners to practice environmental and social safeguard standards.[190] In the EU, a number of governments addressed inconsistencies between public and private regimes by declaring sustainability certification the "sine qua non" of forest governance. For example, the UK, a leader in green procurement policies, will accept FLEGT licenses for public purchases until 2015 at which time sustainable timber certification will be required (Brack & Buckrell 2011). Denmark has taken a similar approach by accepting both the FSC and PEFC as proof of legal and sustainable wood (Gulbrandsen, 2014).

This example of national government orchestration raises the broader question of whether other kinds of entities outside a particular regime can provide a coordinating influence in a regime complex. For example, activist networks helped to catalyze and align the EU and US

190 For example, in Ghana , See "Ghana – European Community, FLEGT Voluntary Partnership Agreement Briefing Note", November 2009, available at http://ec.europa.eu/development/icenter/repository/Flegt_Ghana_VPA_BriefingNotes_4.pdf

legislative efforts on illegality verification in the forestry regime complex. They guided European officials to the US Lacey Act as a model for legislation, and also encouraged US legislators to amend the Lacey Act by pointing to the EU FLEGT initiative. Finally, they used the passing of the Lacey Act Amendments to bolster support for EU legislators to pass the EU Timber Regulation (see Chapter 6). In addition, a similar network of forest activists helped to orchestrate the organizational field of private forest certification. The watchdog organizations, environmental NGOs, governments and retailers who supported the FSC leveraged their collective voice and the monitoring capabilities to publicly compare how industry-led programs stacked up against the FSC. Similarly, scientists and other experts may present orchestration capabilities. For example, Abbott's (2011) argument that the UNFCCC/Kyoto Protocol/CDM acts as an orchestrator insofar as private carbon offset programs choose to utilize CDM values suggests that the key orchestration mechanism is the expertise underlying the CDM.

Building from the above discussion, in this section I propose a theory of orchestration to explain coordination in the biofuels regime complex.

Orchestration through evolutionary learning

Ansell's (2011) notion of "evolutionary learning" describes how large-scale governance institutions undergo change through a process of defining and implementing broad meta-norms. Meta-norms are high-level ideas, values or guidelines set by actors in large-scale institutional settings. They are interchangeable with the overarching framework goals set in experimentalist governance, like "sustainable development." Evolutionary learning emphasizes the gradual development of meta-norms across multiple scales, in the institutions that comprise an individual regime. It involves distributed network of smaller scale entities that are similarly engaged in trying out local strategies to implement a particular meta-norm.

When smaller-scale entities skillfully implement meta-norms, their strategies can draw the attention of other entities engaged with the same challenge. If such entities find success with the same strategy, the meta-norm gathers ideational and institutional force, moving a group of entities towards a similar end goal that was previously undefined.[191] As a theory of change, evolutionary learning entails continuous feedback between overarching meta-norms and concrete local actions. Eventually, the accumulation of small-scale changes drives change in large-scale governance institutions, even those which are generally considered inert, mired in tradition, or otherwise unchangeable. Evolutionary learning unfolds at the scale of a whole policy sector or even for a global governance issue. As such it is consistent with the scale of regime complexes as well as with experimentalist architecture.

To develop small-scale strategies, entities conduct experiments with "meta-concepts."[192] Meta-concepts are the ideas, strategies and practices that operationalize a particular meta-norm.

[191] Ansell (2011) explains that local actions gradually push back on the meaning of overarching meta-norms, provoking revisions to a particular meta-norm. Meta-norms, in turn, constrain local action, steering distributed entities towards a similar end goal. His describes this continuous feedback loop as a kind of co-production of overarching meta-norms and concrete local actions.

[192] Ansell provides the example of the "general strike" in nineteenth-century France as a meta-concept. Despite different working class understandings about what a general strike entailed, French labor unions aligned around this

Ansell (2011) conceives of meta-concepts as the locus of coordinative power in evolutionary learning. As an example of the relationships between meta-norms and meta-concepts, and the coordinative power of meta-concepts, Ansell (2011) points to Local Agenda 21, a global sustainable development program introduced at the 1992 Earth Summit in Rio de Janeiro. Local Agenda 21 provides communities with a framework for implementing the broad meta-norm of "sustainable development." Communities around the world have experimented with how to translate the framework's ambiguous set of goals and procedures into local action plans. A common focus of these community-level experiments has been sustainability indicators.

As a meta-concept, sustainability indicators draw together new publics comprised of diverse groups of Local Agenda 21 stakeholders. Ansell (2011) describes their interactions as a "constitutional process," in which stakeholders who are linked together by their shared concern for how to implement a meta-norm (e.g. sustainable development) come together to deliberate on meta-concepts that operationalize the meta-norm (e.g. sustainability indicators).[193] In the case of Local Agenda 21, stakeholders include governments, firms, advocacy groups, international organizations and other actor groups with a stake in governance outcomes around the implementation of Local Agenda 21's framework for "sustainable development." These stakeholders engage in deliberations on ways to implement a particular meta-concept. They develop experimental strategies. If such strategies are successful, a wider array of publics may choose to experiment with the same meta-concept. This constitutional process unfolds at an ever-larger scale as a widening public experiment with the particular meta-concept.

Growing publics, anchored by the same meta-concept, become the basis for pushing institutional evolution forward. In the case of Local Agenda 21, the impact of sustainability indicators on local sustainable development may be modest. But, from an evolutionary learning perspective, the development of sustainability indicators brought together different Local Agenda 21 communities over two decades of conversations in ongoing conversation that is anchored by deliberation on sustainability indicators as strategies for achieving sustainable development.

Thus, the coordinative power of evolutionary learning processes depends on the uptake and diffusion of meta-concepts. Meta-concepts are flexible enough to cycle through local and global exchanges such that no one has unilateral control over others. Diverse communities of practice must be able to translate the meta-concept for their local purposes. At the same time, meta-concepts must be sturdy enough to guide diverse local actions. Thus, a successful meta-concept not only provides a platform for interaction between small-scale experiments and large-scale meta-norms; it also guides small-scale experiments in a common direction. This soft teleological nature of meta-concept provides an ideal end state, a common direction towards which a plurality of projects and goals move in a broad, yet directed trajectory of change. Thus, meta-

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concept. By uniting a fragmented union movement, the "general strike" helped generate a new public, which became the basis for a dramatic re-ordering of working class institutions (Ansell 1997, 2001).

[193] Ansell's notion of constitutional process draws from Selznick (1996) and Sabel (1999), but unlike these perspectives of which conceive of a constitutional process as taking place at the level of a single organization, constitutional processes in evolutionary learning operate at much larger institutional scales, for an entire policy sector or even for a global governance issue.

concepts accommodate localized experimentation while facilitating interaction between stakeholders in different contexts.[194]

Experts and evolutionary learning in the biofuels regime complex

Evolutionary learning can help to explain how experts act as orchestrators in the biofuels regime complex. The argument developed here is that evolutionary learning empowered a certain group of experts to steer the biofuels regime complex towards accepting iLUC as a legitimate issue worthy of governance. Here, I will briefly examine the iLUC controversy as a part an evolutionary learning process. I then discuss how evolutionary learning empowered experts to act as orchestrator by reducing the potential for rule inconsistencies in the regime complex for biofuels governance. Specifically, I propose that a small group of experts were able to advance science-policy narratives in ways they would not be able to if they were providing information in other contexts.

As discussed in Chapter Seven, the regimes complex for biofuels governance emerged around public pressures to demonstrate the sustainability and low-carbon value of different biofuel commodity chains. One of the key challenges in creating assurance systems for low-carbon biofuels has been defining what low-carbon means and how to calculate it. Lifecycle GHG calculators for complex agricultural commodity chains remain relatively under developed. Absent some kind of science-based organization to provide policymakers clear guidance, the biofuels regime complex quickly became engulfed in scientific controversy over how to model the lifecycle GHG emissions of different biofuel commodity chains, and more specifically, whether such models should include indirect land use change (iLUC) as a variable. By comparison, the regime complex for climate change governance has well-developed scientific advisors, for example in the IPCC and the CDM program, that supply technical information that other public and private regimes within the regime complex rely on to develop and implement their climate governance strategies. Such scientific and technical bodies can help reduce uncertainty or provide decision-makers with guidance in navigating scientific uncertainties.

Lacking such guidance, individual regimes in the biofuels regime complex engaged in an evolutionary learning process for the meta-norm "low carbon fuel" and the meta-concept of carbon intensity: the calculated value of aggregate lifecycle GHG emissions that is assigned to a given biofuel commodity chain for the purposes of determining whether said biofuel provides a net improvement to climate change as compared to gasoline or diesel fuel. As a meta-norm, low carbon fuel must be operationalized at local levels through experimentation with meta-concepts. Carbon intensity emerged as a controversial meta-concept, given the lack of expert consensus regarding whether indirect land use change (iLUC) should be included in models used to calculate carbon intensity. Diverse publics emerged around the meta-concept of carbon intensity, engaged in thick debate on the question of iLUC.

Experts supporting the inclusion of iLUC factors in GHG calculators were particularly empowered in the context of evolutionary learning. As research has shown, the structural and

[194] Ansell uses the term "boundary objects" based on the definition provided by Star and Griesemer, who define boundary objects as "objects which are both plastic enough to adapt to local needs and the constraints of the several parties employing them, yet robust enough to maintain a common identity across sites" (1989, 393).

procedural constrains of the decision-making venue determines how experts participate in governance. As Keller (2009) shows, scientists' participation varies across policy stages, impacting the degree to which scientists are able to participate in policymaking as advocates verses disinterested, objective technical advisors. During agenda setting policy stages, scientists and other technical experts are often relied upon to help frame the agenda and set the terms of the debate. For example, policy makers in the US turned to climate scientists to raise public awareness about climate change as a serious global problem beset with uncertainty. As the policy process extended from agenda setting, technical input became subject to greater scrutiny. Recall, for example, the scrutiny that the US climate scientist James Hansen faced during his 1998 legislative testimony; it sparked criticism that would not have occurred in the agenda-setting stage. In the more formal policymaking settings, scientists face more pressure to appear objective. During formal policy implementation, scientists are often even more constrained by the requirement to provide technical advice, whereas other actors at this stage may still advance value-laden policy narratives about why a particular course of action is good or bad.

Without formalized structures and procedures that keep experts in objective roles, Keller's work demonstrates that scientists are able to advance science narratives with policy implications in less formal settings; they can perform a kind of boundary work that would be considered unacceptable in more formal settings.

Kohler et al. (2012) show a similar phenomenon at work in global environmental governance. The structural and procedural context in which governance negotiations unfold affects how experts participate, be it in a subsidiary body, a global environmental assessment, or a stand-alone advisory panel. For example, parties to an international agreement may seek to enhance both the credibility and legitimacy of scientific advice to ensure that technical evidence is not questions as biased or unfair in its treatment of opposing viewpoints, beliefs and values. Yet enhancing credibility and legitimacy may undermine salience may come at the cost of enhancing the salience of scientific outputs for the needs of decision-makers. In other venues, decision-makers may seek a different balance of credibility, legitimacy, or salience (Cash et al., 2003; in Kohler et al., 2012). Such criteria are tightly coupled.[195]

[195] Enhancing one of these can come at the expense of another, making it difficult to achieve success across all three criteria (Kohler et al, 2012).

Chapter 9 Conclusion

Societies worldwide face concerns about transgressing planetary boundaries, surviving imminent climate change impacts, and accessing food, energy, water, housing, and many more human needs. In response, companies, governments, and researchers are developing an ensemble of technologies to reduce the environmental impacts of industrialized production and consumption, and to enable clean, equitable development in impoverished areas. These technologies include liquid fuels, solar panels, chemicals, genetically modified seeds, battery-powered cars, and many other things whose existence and/or usefulness is predicated on providing an alternative that displaces fossil fuel production or consumption. Such technologies inevitably represent a coalescence of trade-offs and uncertain promises. Often, they are introduced into markets and neighborhoods with haste, justified by the need to mitigate greenhouse gas emissions, build the green economy, or feed the world. Once they are "released" into everyday life, they may not be as benign as they were portrayed, thus creating a technological trajectory that is harmful to some group of humans or non-humans.

Thus, the question of "who decides" is ever important for those seeking to build the low-carbon future. The answer cannot be reduced to those who claim expertise over the most technologically sweet solutions to GHG reductions, nor can it be the specialists who have acquired responsibility for decision issues of public concern.

If fossil fuels are what made the industrial revolution, is there a qualitative change in how societies pursue material developments for non-fossil fuel energy? Following the idiom of co-production, this dissertation suggests that the relationship between energy and democratic politics is intertwined; the production of low-carbon energy materialities and the production of political orders are embroiled. As Timothy Mitchell (2011) asserts in Carbon Democracy, "Like energy from fossil fuels, democratic politics is a recent phenomenon. The development of the two kinds of power has been interwoven from the start."

Who decided what ethanol production should look like? What sociotechnical imaginaries have guided industry development? What social and political factors moderated it? What are the implications of national political cultures of economic governance for green industrial policymaking?

One way to explore these answers is to look closely at how ideas, discourses, cognitive paradigms, social norms, cultural traditions have shaped various trajectories of ethanol development and governance. This dissertation has showcased different perspectives on how ideas, discourses, cognitive paradigms, social norms, cultural traditions have shaped outcomes in the history of ethanol development, in order to argue that on a larger scale, such ideational forces are shaping just transitions. Many scholars of political economy and governance have examined the relationship between ideas and policy outcomes, generating a variety of different approaches. Some have focused on the causal mechanisms through which ideas influence policy (Campbell, 2002; Campbell, 1998). For example, actor-centric accounts reveal how scientists, academics,

intellectuals, and others whose expertise amplifies their voice in policy debates can influence public policy. The ideas of economists have proven powerful in industrial and macroeconomic policymaking. At the transnational level, epistemic communities—networks of professional experts who share notions of empirical validity (Haas, 1992)—have influenced international treaties. Transnational advocacy networks have been influential in this regard too. By framing empirical information as normative statements and disseminating packages of ideas across multiple jurisdictions, they have swayed powerful policy actors to adopt their positions (Keck and Sikkink, 1998; Risse, 1999). Both parts of this dissertation aim to contribute to these varied approaches.

Part One shows that behind rhetorical façade of neoliberal ideology, state-centric development strategies continue to be a driving force in global production network for ethanol. In both countries, government support for expanding ethanol trade and production globally comes in many forms, most recently, in the significant public investments to scale cellulosic technological innovation systems favorably for Brazilian and American producers. The promise of cellulosic ethanol is access to new sugar sources in the service of a number of goals defined in the public interest, including climate change mitigation, rural development, and increased agro-ecological benefits such as conservation of natural resources and biodiversity.

To examine ethanol development in US and Brazil in this way has a number of implications for researchers and policy advocates. First, this cross-national comparison of ethanol development underscores the value of understanding the economy as a socially embedded "market society," in which the state has been playing a major role from the 19th century onward (Block, 2012).[196] But it also highlights the difficulty of classifying state-economy typologies in the post-neoliberal era. Today, ethanol producers from both a newly industrialized nation (Brazil) and a global economic superpower (US) remain at the helm of the global ethanol production network in large part due to government intervention. The policy pathways taken in each case have been distinct overall, despite some points of convergence since the onset of neoliberal institution building (for example, in the use of Science and Technology Policy to help scale cellulosic ethanol development). This research shows that neither country fits neatly on the spectrum of "varieties of capitalism" (Hall and Soskice, 2001); by examining the distinct political cultures of economic governance, ethanol imaginaries, and ethanol policymaking for each country, the US is not so clearly a liberal market economy, nor Brazil a coordinated market economy.[197] This observation reinforces the idea that regulatory restructuring pathways "after neoliberalism" are context specific and inherently unpredictable (Brenner et al., 2010). Much work remains to be done to understand how the contemporary trajectories of market society are embedded in context-specific policy struggles and political cultures of economic governance.

Second, this research sheds new light on what kinds of state capacities are needed to facilitate democratic responses to climate change. This research suggests industrial policymaking should be understood as opportunities to transform democratic politics. Moments of national

[196] Block (2012) argues that Polanyi's theory of "market society" better reflects modern political-economic issues than either traditional Marxism or Wallerstein's world-system theory.
[197] Hall and Soskice (2001) propose that capitalist economies are of two variations: coordinated market economies and liberal marked economies.

crisis, when an existing toolbox for economic policy appears to be lacking, are openings for institutional change and the transformation of state capacities. Scholars have pointed out that neoliberal reforms have eroded many of the state capacities needed for climate mitigation and adaptation (Fieldman, 2011; Adger, 2003). Most literature considers climate change related capacities in terms of disaster preparedness and relief. To the extent that low-carbon development can contribute to climate change adaptation and mitigation, this research highlights the need to also consider state capacities in relation to industrial policy. State capacities needed for a democratic project of equitable low-carbon economic development will not be 'one size fits all.' Green industrial policy approaches will have to address many different kinds of neoliberalism. Thus, the issue here is not necessarily how to restore some set of pre-neoliberal capacities, but how to attend to the constraints that impede the development of democratically responsive state capacities in the climate policy and green industrial policy arenas.

The history of biofuel development, like the history of fossil fuel development, is rife with environmental destruction and social injustices that are linked to the absence of democratically responsive decision-making.[198] Similarly, solar policymaking has produced a number of unintended consequences for worker health, community health, and the environment (Mulvaney 2014). Numerous reports from California—arguably the most active site of green industrial policymaking among US states—shows how climate policy as industrial policy can exacerbate the environmental burdens of communities living near industrial pollution hotspots and increase the social vulnerabilities of low-wage workers and those impacted by gentrification-driven displacement and the lack of affordable housing (Shonkoff et al., 2009; London, et al., 2011; Sze, et al. 2009). In industrial policy for energy development and industrial policy more generally, capital sways the state apparatus, undermining the democratic responsiveness of government.

Sociotechnical imaginaries, as one particular form of statecraft, may present an opportunity to enhance the democratic responsiveness of state capacities. Ethanol imaginaries typically foreground the benefits of ethanol development to capital but downplay the real and potential risks to other groups. As the cases show, state actors translate the contents of these imaginaries into end goals that get written into policy agendas. Broadening the end goals of climate policy agendas is something researchers and activists have attempted in recent years by pushing policymakers to treat low-carbon development initiatives as vehicles for improving economic equity, remedying environmental injustice, and reducing disparities in public health and access to clean energy (Zabin and Martin, et al. 2016; Newell and Mulvaney 2013; Shonkoff et al., 2009}. Outside of the climate policy arena, there are similar calls for overhauling industrial policy more generally to redirect public resources away from military missions (e.g. space-based weaponry) towards firms that address the global climate crisis, disease and poverty (Block, 2008). Yet such efforts do not go so far as to articulate alternative sociotechnical imaginaries fashioned according to the desired benefits and undesired risks facing vulnerable communities or even the general public.

[198] As shown in some excellent histories tracing the development of fossil fuel industries in North America and Europe, the democratic capacities of government in energy development have been weak, with private sector boosters and cartels exerting strong influence over how fossil energy developed. See Mitchell's *Carbon Democracy,* (2011), Jones's *Routes of Power* (2014), Andrew's *Killing for Coal* (2010).

Absent alternative imaginaries, state sociotechnical imaginaries that reflect the preferences of capital and technocrats can translate into policy agendas that may fundamentally preclude the broadening of end goals. For example, in both Brazil and the US, sociotechnical imaginaries for cellulosic ethanol project a future agricultural landscape that features greater agro-ecological diversity achieved through biotechnology applications. In this new imagined agricultural landscape, the risks of genetically modified monoculture crops and the struggles of smallholder livelihoods and small producers are not depicted. Omissions like these put communities that are negatively affected by an imaginary in a reactive position, whereby attempts to introduce broader end goals into a policy arena are thwarted by discourses of cellulosic ethanol that have already "closed" around a particular sociotechnical system.

Third, this research also suggests that transforming the means of industrial policymaking (i.e. the tools and strategies) is also necessary. Rearticulating imaginaries may help to broader the end-goals of green industrial policy, but this alone is insufficient for developing more democratically responsive statecraft. In the US, where the political rationality for positive state intervention is weak, the political culture of economic governance has geared state capacities towards achieving the efficient allocation of government contracts. Technocrats at the Department of Energy work to improve the outcomes that result from the distribution of public resources to government and university researchers as well as firms. With better due diligence, technocrats can promise less failures like abandoned industrial plants, polluted communities, or weapons acquisitions scandals, and more successes in supporting autonomous, competitive firms that lead global industries like agriculture, aerospace, petrochemicals, biotechnology, information technology, and semiconductors.[199] Industrial policy scholars agree that improved due diligence can help ensure more efficient outcomes (See Rodik 2008), especially if technocrats can incorporate socially-desirable criteria into their due diligence, such as whether firms fulfill a social contract of achieving greater environmental protection, enhancing employee welfare, and creating more resilient communities (See, Block 2008; Mulvaney 2014).

Yet technocratic improvements like better due diligence may do little to improve democratic responsiveness without transformations to a nation's political culture. In the cases, the analysis of sociotechnical imaginaries of ethanol show how broader logics of statecraft can act as institutional constrains in democratic decision-making around sociotechnical change. This suggests a need for alternative discourses that challenge dominant narratives about how the economy functions and who should decide the nation's economic future. Part of the task for scholars, argues Deirdre McClosekey, is to contribute, in some small way, to a more nuanced understanding state and markets by bringing economics back into "the conversation of humankind." Donald MacKenzie (2006, p. 26) notes that ongoing disagreements about the appropriate role for markets in our societies are contentious not only because of the great disparities in wealth and power that reinforce beneficial outcomes for particular interest groups, but also because:

[199] For a more detailed discussion on what this would entail, see Rodik (2007). Critics of industrial policy argue that states are inherently too weak and ill equipped to single out certain industries, firms or technologies as deserving of public support. Governments lack the omniscience needed to maintain the natural dynamics of market competition, thereby creating suboptimal economic outcomes and outright failures. Inevitably, industrial policy generates authoritarianism and corruption, leading to what the fiscal conservatives of the US Republican party often refer to as "crony capitalism".

> … those who come to those conversations often bring strong, deeply felt preconceptions. Some are convinced that markets are sources of human freedom and prosperity; others believe markets to be damaging generators of alienation, exploitation, and impoverishment. Currently, that divide tends to map onto a disciplinary one, with mainstream economists approving profoundly of markets and with sociologists and anthropologists frequently manifesting deep, albeit often unexplicated, reservations about them. (2006: 25)[200]

This divide was famously brought into sharp relief in 1944, with the publication of Hayek's The Road to Serfdom and Polanyi's The Great Transformation. The two books represent starkly different paradigms of freedom and regulation in the market economy (Filip, 2014; Block, 2001). Hayek's book defends free market capitalism against New Deal era reforms and more generally against any socialist force or movement working to advance distributive justice. For Hayek, using state authority to achieve distributive justice had costly consequences for society, and therefore state intervention should be limited to protecting the citizenry against fascist coercion, defending against foreign military attacks, and regulating property rights. For Hayek, state intervention beyond these functions threatened the self-regulating market system and ushered in thriving totalitarian regimes (i.e., fascism, Nazism, or communism). For Polanyi, market liberalism was a utopian project that results in destructive crises of capitalism. The self-regulating market system had never existed; it had always been the result of deliberate decision-making by the state. As Polanyi argued, "Regulation and markets . . . grew up together" (Polanyi 2001, p. 71), and therefore regulations were needed to constrain the destructive influence of market forces.[201] Like Hayek, he did not advocate for state socialism's centrally planned economy. Polanyi proposed a system that merged some components of the planned economy with some components the market economy, but did not elaborate a positive conception of the state (Filip, 2014). Classical and neoclassical economists have helped undermine positive conceptions of state power; their depiction of the economy as a Darwinian system wherein the 'survival of the fittest' doctrine renders the state superfluous. Even radical political movements from the 1960s onwards have struggled to clarify the balance of state and market power due in part due to a general distrust of centralized authority (Hunt, 2003, p. 255-262).

One way to develop more nuanced views of the market is to pay more attention to the knowledge politics and kinds of expertise that shape a society's political culture of economic governance as well as the ways in which experts assume power in new multi-level governing arrangements where there is often a lacuna of clear governmental authority. This requires abandoning the view of markets as bound by an autonomous, universal logic, to which society may either conform or reject. A more nuanced view would understand markets as politically and culturally constructed, comprised of logics that can be significantly modified. For guidance, MacKenzie (2006, p. 26) suggests looking to the accomplishments of STS researchers. Scholars working within the history and sociology of technology have shown how the design of technical systems can develop according to a variety of priorities and circumstances, and can be frequently remade in important ways.

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[200] MacKenzie, Donald, 2006, *An Engine, Not a Camera: How Financial Models Shape Markets*, MIT Press: Cambridge, MA.

[201] Part of the problem, Polanyi argued, was that neoclassical economics perpetuates the notion of freedom as the pursuit of self-interest—a narrow definition that had no regard for ethics, equality or justice (Filip, 2014). Polanyi saw the state as necessary for the pursuit of a more authentic conception of freedom as the pursuit of autonomy, self-development, and rational self-determination.

In parallel, more nuanced views of state power are needed. This requires pushing beyond popular discourses that cast the state in stark terms, as either a relatively good actor (strong, capable) or a relatively bad one (weak, captured, corrupted), to understanding that different forms of state governance produce a range of political effects. DuPuis and Block (2008) propose a more "reflexive" view of the state, one that rejects the anti-statist perspectives found in romantic notions of local governance.[202] Governance occurs at multiple scales, resulting in the co-production of top-down policies and grassroots policies. With this perspective, researchers may uncover governance forms that may inadvertently advance local agendas for environmental and social justice. Further, multilevel governance structures facilitate cross-pollination and learning across different policy scales. For example, subnational, national, and supranational governance forms of governance often work in tandem and policy experiments conducted at one level can impact the approaches used in other levels.

In practice, in order for more nuanced views of state power and market logic to address the democratic deficit of industrial policy, new policy experiments are needed to establish new practices. This work cannot come from academic researchers, but must be articulated by actors working in specific policy arenas. But from where and which groups in society can counter-hegemonic change to political culture materialize? One area of practice has to do with increasing opportunities for public deliberation on the direction of technological change and economic development, expanding the space of public deliberation over the direction of sociotechnical change.[203] Deliberative governance networks are key here, as they empower new spaces and shape the formal institutions they interact with (Dryzek, 2010, p. 13).

Moving towards a collective low-carbon future requires numerous transformations. Carbon itself must be transformed, kept in the ground, removed from the air, or avoided altogether. But so too must these transformations involve developing new relationships, new alliances, new democratic capabilities, and new understandings of what the future possibilities mean for different groups.

[202] DuPuis and Block (2008) examine the historical development of milk-market order systems in two US regions to critique anti-statist perspectives that view any kind of state interference in agribusiness to be a form of industry capture that undermines sustainable agricultural systems. They urge practitioners of sustainable agriculture to think beyond the local scale, to identify multi-level governance structures that support local, sustainable agriculture.
[203] As economic sociologist Fred Block argues, expanding broader participation "is necessary to overcome the democratic deficit of existing developmental efforts and to reduce the vested power of military and entrenched industries" (2008, p. 199).

References

Abbott, K. W. (2012). The transnational regime complex for climate change. *Environ. Plann. C Environment and Planning C: Government and Policy*, *30*(4), 571–590.

Abbott, K. W., & Snidal, D. (2009). The Governance Triangle : Regulatory Standards Institutions and the Shadow of the State. *The Politics of Global Regulation*, 44–88.

Acemoglu, Daron, Philippe Aghion, Leonardo Bursztyn, & David Hemous. (2012). The Environment and Directed Technical Change. *American Economic Review*, (1), 131. https://doi.org/10.1257/aer.102.1.131

Adger, W. N. (2003). Social Capital, Collective Action, and Adaptation to Climate Change. *ECGE Economic Geography*, *79*(4), 387–404.

Aggarwal, V. K., & Morrison, C. E. (1998). *Asia-Pacific crossroads : regime creation and the future of APEC*. New York: St. Martin's Press.

ALFREDO SAAD FILHO. (2010). Neoliberalism, Democracy, and Development Policy in Brazil. *Development and Society*, *39*(1), 1–28.

Alter, K. J., & Meunier, S. (2009). The Politics of International Regime Complexity. *Perspectives on Politics*, *7*(01), 13–24. https://doi.org/10.1017/S1537592709090033

Amann, E., & Baer, W. (2005). From the developmental to the regulatory state: the transformation of the government's impact on the Brazilian economy. *QUAECO Quarterly Review of Economics and Finance*, *45*(2), 421–431.

Amann, E., & Baer, W. (2008). Neo-liberalism and market concentration in Brazil: The emergence of a contradiction? *QUAECO Quarterly Review of Economics and Finance*, *48*(2), 252–262.

American Petroleum Institute and National Petroleum Refiners Association v. Environmental Protection Agency. 52 F.3d 1113 (D.C. Ct. App. 1995).

Anderson, B. R. O. (1983). *Imagined communities : reflections on the origin and spread of nationalism*. London; New York: Verso.

Andrews, T. G. (2008). *Killing for coal : America's deadliest labor war*. Cambridge, Mass.: Harvard University Press.

Ansell, C. (2000). The Networked Polity: Regional Development in Western Europe. *Governance*, *13*(2), 279–291.

Ansell, C. K. (2011). *Pragmatist democracy : evolutionary learning as public philosophy*. Oxford; New York: Oxford University Press.

Arbix, G., Martin, S. B., & Center, G. L. S. (2010). Beyond developmentalism and market fundamentalism in Brazil: inclusionary state activism without statism. In *WORKSHOP ON "STATES, DEVELOPMENT, AND GLOBAL GOVERNANCE". Madison: Global Legal Studies Center and the Center for World Affairs*. Retrieved from http://law.wisc.edu/gls/documents/paper_arbix.pdf

Auld G., Cashore B., Bozzi L., Renckens S., & Balboa C. (2010). Can technological innovations improve private regulation in the global economy? *Bus. Polit. Business and Politics*,

12(3).

Auld, G., Gulbrandsen, L. H., & McDermott, C. L. (2008). Certification Schemes and the Impacts on Forests and Forestry. *Annual Review of Environment and Resources*, *33*(1), 187–211. https://doi.org/10.1146/annurev.environ.33.013007.103754

Baccini A., Goetz S.J., Walker W.S., Laporte N.T., Sun M., Hackler J., … Dubayah R. (2012). Estimated carbon dioxide emissions from tropical deforestation improved by carbon-density maps. *Nat. Clim. Change Nature Climate Change*, *2*(3), 182–185.

Backstrand, K. (2008). Accountability of Networked Climate Governance: The Rise of Transnational Climate Partnerships. *Global Environmental Politics*, *8*(3).

Baer, W. (2008). *The Brazilian economy : growth and development*. Boulder, CO: Lynne Rienner Publishers.

Ban, C. (2013). Brazil's liberal neo-developmentalism: New paradigm or edited orthodoxy? *Review of International Political Economy*, *20*(2), 298–331.

Barber, W. J. (1996). *Designs within disorder : Franklin D. Roosevelt, the economists, and the shaping of American economic policy, 1933-1945*. Cambridge; New York: Cambridge University Press.

Barley, S. R., & Tolbert, P. S. (2016). Institutionalization and Structuration: Studying the Links between Action and Institution. *Organization Studies Organization Studies*, *18*(1), 93–117.

Bartley, T. (2007a). How Foundations Shape Social Movements: The Construction of an Organizational Field and the Rise of Forest Certification. *Social Problems*, *54*(3), 229–255.

Bartley, T. (2007b). How Foundations Shape Social Movements: The Construction of an Organizational Field and the Rise of Forest Certification. *Social Problems*, *54*(3), 229–255. https://doi.org/10.1525/sp.2007.54.3.229

Bartley, T. (2007c). Institutional emergence in an era of globalization: The rise of transnational private regulation of labor and environmental conditions. *American Journal of Sociology*, *113*(2), 297–351.

Bartley, T. W. (2003). *Certifying forests and factories: The emergence of private systems for regulating labor and environmental conditions* (Ph.D. Dissertation). The University of Arizona. Retrieved from http://arizona.openrepository.com/arizona/handle/10150/280343

Barzelay, M. (1986). *The politicized market economy : alcohol in Brazil's energy strategy*. Berkeley: University of California Press.

Bauer, S., & Biermann, F. (2004). Does effective international environmental governance require a World Environment Organization? the state of the debate prior to the Report of the High-Level Panel on Reforming the United Nations.

Beisheim, M., & Dingwerth, K. (2008). *Procedural legitimacy and private transnational governance are the good ones doing better?* Berlin: SFB 700.

Benner, T., Reinicke, W. H., & Witte, J. M. (2004). Multisectoral Networks in Global Governance: Towards a Pluralistic System of Accountability. *Government and*

Opposition, *39*(2), 191–210.

Bernstein, S., & B. Cashore, B. (2004). Is Forest Certification a Legitimate Alternative to a Global Forest Convention? In Kirton, J. J. & Trebilcock, M. J. (Eds.), *Hard Choices, Soft Law: Voluntary Standards in Global Trade, Environment and Social Governance*. Surrey, UK: Ashgate.

Bernstein, S., & Cashore, B. (2007). Can non-state global governance be legitimate? An analytical framework. *Regulation & Governance*, *1*(4), 347–371. https://doi.org/10.1111/j.1748-5991.2007.00021.x

Betsill, M. M., & Corell, E. (2001). NGO Influence in International Environmental Negotiations: A Framework for Analysis. *Global Environmental Politics*, *1*(4), 65–85.

Biedenkopf, K., & Zeitlin, J. (2015). EU Chemicals Regulation: Extending Its Experimentalist REACH. In *Extending Experimentalist Governance? The European Union and Transnational Regulation* (pp. 107–36). Oxford: Oxford University Press.

Biermann, F. (2007). Earth system governance as a crosscutting theme of global change research. *JGEC Global Environmental Change*, *17*(3), 326–337.

Biermann, F., & Pattberg, P. H. (2008). Global environmental governance : taking stock, moving forward. *Annual Review of Environment and Resources.*, *33*, 277–294.

Biermann, F., Philipp Pattberg, Harro van Asselt, & Fariborz Zelli. (2009). The fragmentation of global governance architectures : a framework for analysis. *Global Environmental Politics*, *9*(4), 14–40.

Bijker, W. E. (1995). *Of bicycles, bakelites, and bulbs : toward a theory of sociotechnical change*. Cambridge, Mass.: MIT Press.

Bijker, W. E., Hughes, T. P., & Pinch, T. (1989). The Social construction of technological systems : new directions in the sociology and history of technology. MIT Press.

Black, B. (2000). *Petrolia : the landscape of America's first oil boom*. Baltimore: Johns Hopkins University Press.

Block, F. (2008). Swimming Against the Current: The Rise of a Hidden Developmental State in the United States. *Politics & Society*, *36*(2), 169–206. https://doi.org/10.1177/0032329208318731

Block, F., & Keller, M. R. (2011). Where do innovations come from? Transformations in the US Economy, 1970-2006. *Reasserting the Public Interest Knowledge Governance*, 81–104.

Block, F. L., & Keller, M. R. (2011). *State of innovation : the U.S. government's role in technology development*. Boulder, CO: Paradigm Publishers.

Block, Fred, & Go, Julian. (2012). Varieties of what? Should we still be Using the Concept of Capitalism? In *Political Power and Social Theory* (Vol. 23, pp. 269–291). Emerald Publishing Group.

Block, Fred, & Polanyi, Karl. (2001). Introduction. In *The Great Transformation* (pp. xviii–xxxviii). Boston: Beacon Press.

Bloomfield, J., & Pearson, H. L. (2000). Land use, land-use change, forestry, and agricultural activities in the clean development mechanism: estimates of greenhouse gas offset

potential. *Mitigation and Adaptation Strategies for Global Change*, *5*(1), 9–24.

BNDES (National Development Bank of Brazil), CGEE (Center for Strategic, Studies and Management), CEPAL (UN Economic Commission for Latin America and the Caribbean), & FAO (Food and Agriculture Organization). (2008). *Sugarcane-Based Bioethanol: Energy for Sustainable Development.* Rio de Janeiro: BNDES & CGEE.

Borras, S. M., McMichael, P., & Scoones, I. (2011). *The politics of biofuels, land and agrarian change*. London; New York, NY: Routledge : Taylor & Francis Group.

Borzel, T. A., & Risse, T. (2010). Governance without a state: Can it work? *REGO Regulation & Governance*, *4*(2), 113–134.

Bossche, P., Schrijver, N. J., & Faber, G. (2007). *Unilateral Measures Addressing Non-Trade Concerns: A Study on WTO Consistency, Relevance of other International Agreements, Economic Effectiveness and Impact on Developing Countries of Measures concerning Non-Product-Related Processes and Production Methods* (The Ministry of Foreign Affairs of the Netherlands). The Hague. Retrieved from https://openaccess.leidenuniv.nl/bitstream/handle/1887/12563/Unilateral%20Measures%20Addressing%20Non%20Trade%20Concerns.pdf?sequence=1

Boyd, G. M. (1988, July 12). Bush Vows to Help Farmers Expand Market for Exports. *The New York Times*. Retrieved from http://www.nytimes.com/1988/07/12/us/bush-vows-to-help-farmers-expand-market-for-exports.html

Brack, Duncan. (2014). *Promoting Legal and Sustainable Timber: Using Public Procurement Policy*. London: Chatham House.

Brack, Duncan, & Buckrell, Jon. (2011). *Controlling Illegal Logging: Consumer-Country Measures* (Briefing paper). Retrieved from https://www.chathamhouse.org/publications/papers/view/109642

Bracmort, Kelsi, Schnept, Randy, Stubbs, Megan, & Yacobucci, Brent D. (2011). *Cellulosic Biofuels: Analysis of Policy Issues for Congress* (No. RL34738). US Congressional Research Service.

Brannstrom, C., Rausch, L., Brown, J. C., de Andrade, R. M. T., & Miccolis, A. (2012). Compliance and market exclusion in Brazilian agriculture: Analysis and implications for soft governance. *JLUP Land Use Policy*, *29*(2), 357–366.

Brenner, N., Peck, J., & Theodore, N. (2010). After Neoliberalization? *Globalizations*, *7*(3), 327–345.

Bridge, G. (2008). Global production networks and the extractive sector: governing resource-based development. *Journal of Economic Geography*, *8*(3), 389–419.

Brigham, J. L. (1998). *Empowering the west : electrical politics before FDR*. Lawrence: University Press of Kansas.

Brinkley, D. (1998). *The Unfinished Presidency : Jimmy Carter's Journey beyond the White House*.

Brinkman, Ronald, Jasanoff, Sheila, & Ilgen, Thomas. (n.d.). *Controlling Chemicals: The Politics of Regulation in Europe and the United States*. London: Cornell University Press.

Brown, W. (2006). American Nightmare. *Political Theory*, *34*(6), 690–714.

Brunsson, N., & Jacobsson, B. (2000). *A world of standards*. Oxford; New York: Oxford University Press.

Buckeridge, M. S., Souza, A. P., Arundale, R. A., Anderson-Teixeira, K. J., & DeLucia, E. (2012). Ethanol from sugarcane in Brazil: a midway strategy for increasing ethanol production while maximizing environmental benefits. *GCBB GCB Bioenergy*, *4*(2), 119–126.

Buckeridge, MS. (2009a, June 13). BIOETHANOL IN BRAZIL. Retrieved from https://bioethanolbrazil.wordpress.com/

Buckeridge, MS. (2009b, July). *Science and Technology Overview in Biofuels Research in Brazil*. University of São Paulo, São Paulo, Brazil,.

Bulkeley, H., & Newell, P. (2011). *Governing climate change*. London: Routledge.

Bumpus, A. G. (2011). The Matter of Carbon: Understanding the Materiality of tCO2e in Carbon Offsets. *Antipode*, *43*(3), 612–638.

Burges, S. W. (2005). Auto-Estima in Brazil: The Logic of Lula's South-South Foreign Policy. *Internationalj International Journal*, *60*(4), 1133–1151.

Bush, George. (1988, October). *Presidential Candidates Debates: Presidential Debate at the University of California in Los Angeles*. Retrieved from http://www.presidency.ucsb.edu/ws/?pid=29412

Campbell, J. L. (1998). Institutional analysis and the role of ideas in political economy. *Theory and Society*, *27*(3), 377–409.

Campbell, J. L. (2002). Ideas, Politics, and Public Policy. *Annual Review of Sociology*, *28*(1), 21–38. https://doi.org/10.1146/annurev.soc.28.110601.141111

Campbell, J. L., Hollingsworth, J. R., & Lindberg, L. N. (1991). *Governance of the American economy*. Cambridge [England]; New York: Cambridge University Press.

Cardoso, F. H. (2009). Reforma política: prioridades e perspectivas para a nação brasileira. *Parcerias Estratégicas*, *4*(6), 05–20.

Carolan, M. S. (2009). Ethanol versus Gasoline: The Contestation and Closure of a Socio-technical System in the USA. *Socistudscie Social Studies of Science*, *39*(3), 421–448.

Carter, Jimmy. (1977, April). *Address to the Nation on Energy*. Retrieved from http://www.presidency.ucsb.edu/ws/?pid=7369

Carter, Jimmy. (n.d.). *Address to the Nation on Energy and National Goals: "The Malaise Speech."* Retrieved from http://www.presidency.ucsb.edu/ws/?pid=32596

Casey, J.P. (n.d.). High Fructose Corn Syrup: A Case History of Innovation. *Die Starke*, *29*(6), 196–204.

Cashore, B. (2002). Legitimacy and the Privatization of Environmental Governance: How Non-State Market-Driven (NSMD) Governance Systems Gain Rule-Making Authority. *Governance Governance*, *15*(4), 503–529.

Cashore, B., Egan, E., Auld, G., & Newsom, D. (2007). Revising theories of nonstate market-

driven (NSMD) governance: lessons from the Finnish forest certification experience. *Global Environmental Politics*, *7*(1), 1–44.

Cashore, B. W., Auld, G., & Newsom, D. (2004a). Governing through markets : forest certification and the emergence of non-state authority. Retrieved from http://public.eblib.com/choice/publicfullrecord.aspx?p=3419879

Cashore, B. W., Auld, G., & Newsom, D. (2004b). *Governing through markets : forest certification and the emergence of non-state authority*. New Haven: Yale University Press.

Centro de Gestão e Estudos Estratégicos (CGEE). (2009). *Bioethanol: an opportunity for Brazil*. Brasília, DF: CGEE.

Chandler, A. D. (1977). *The visible hand : the managerial revolution in American business*. Cambridge, Mass.: Belknap Press.

Chatterjee, P. (2004). The politics of the governed : reflections on popular politics in most of the world. Retrieved from http://site.ebrary.com/id/10183506

Cherniavsky, E. (2017). *Neocitizenship : political culture after democracy*.

Chilton, S. (1988). Defining political culture. *Western Political Quarterly*, *41*(3), 419–445.

Chum, Helena. (2002). *Programa Brasileiro de Células a Combustível Proposta*. Centro de Gestão e Estudos Estratégicos Ciência, Tecnologia e Inovação. Retrieved from https://finep.gov.br/images/a-finep/fontes-de-orcamento/fundos-setoriais/ct-energ/programa-brasileiro-de-celulas-a-combustivel.pdf

Clinton, William J. (1997, January). *The President's Radio Address*. Retrieved from http://www.presidency.ucsb.edu/ws/index.php?pid=53546

CMP (Capital Markets Partnerships). (2011). *Sustainable Investment Initiative*. Retrieved from http://mts.sustainableproducts.com/Capital_Markets_Partnership/Lacey/Lacey%20Due%20Care%20Standard.pdf

Codato, A. N. (2006). *Political transition and democratic consolidation : studies on contemporary Brazil*. New York: Nova Science Publishers.

Cohen, J., & Sabel, C. F. (2005). Global democracy? *New York University Journal of International Law and Politics.*, *374*, 763–797.

Colander, D. C., & Landreth, H. (1996). *The coming of Keynesianism to America : conversations with the founders of Keynesian economics*. Chelteenham, UK; Brookfield, Vt.: E. Elgar.

Collins, J. L. (2006). New Directions in Commodity Chain Analysis of Global Development Processes. *Bs:RRSD New Directions in the Sociology of Global Development*, *11*, 3–17.

Comim, F. (2002). The Scottish tradition in economics and the role of Common sense in Adam Smith's thought. *Review of Political Economy*, *14*(1), 91–114.

Conca, K., Alberty, M., Dabelko, G. D., & Harrison Program on the Future Global Agenda. (1995). *Green planet blues : environmental politics from Stockholm to Rio*. Boulder, Colo.: Westview Press.

Conca, Ken. (2005). *Governing Water: Contentious Transnational Politics and Global*

Institution Building. Cambridge, Ma.: MIT Press.

Coolidge, Calvin. (1925, January). *Address to the American Society of Newspaper Editors, Washington, D.C.* Retrieved from http://www.presidency.ucsb.edu/ws/?pid=24180

Corbera, E., Soberanis, C. G., & Brown, K. (2009). Institutional dimensions of Payments for Ecosystem Services: An analysis of Mexico's carbon forestry programme. *ECOLEC Ecological Economics*, *68*(3), 743–761.

Corell, E., & Betsill, M. M. (2001a). A Comparative Look at NGO Influence in International Environmental Negotiations: Desertification and Climate Change. *Global Environmental Politics*, *1*(4), 86–107.

Corell, E., & Betsill, M. M. (2001b). A Comparative Look at NGO Influence in International Environmental Negotiations: Desertification and Climate Change. *Global Environmental Politics*, *1*(4), 86–107.

Correa, Hélio. (1980). *Cultural Practices for Large Cassava Plantations* (Cassava Cultural Practices: Proceedings of a workshop held in Salvador, Bahia, Brazil, 18-20, March 1980 No. ARCH 40248) (pp. 120–130). Ottawa, CA: International Development Research Center.

Cotoi, C. (2011). Neoliberalism: a Foucauldian perspective. *International Review of Social Research*, *1*(2), 109–124.

Council of Economic Advisors. (1964). *Economic Report to the President, Transmitted to Congress January 1964 Together with the Annual Report*. Retrieved from http://www.presidency.ucsb.edu/economic_reports/1964.pdf

Counsell S., & Loraas K. T. (2002). *Trading in credibility: The myth and reality of the Forest Stewardship Council*. London, England: Rainforest Alliance.

Cramer Commission. (2006). *Criteria for sustainable biomass production*. Project group on Sustainable production of biomass, Interdepartmental Programme Management Energy Transition, the Netherlands.

Crutzen, P. J., Mosier, A. R., Smith, K. A., & Winiwarter, W. (2007). N2O release from agro-biofuel production negates global warming reduction by replacing fossil fuels. *Atmospheric Chemistry and Physics*, *7*, 11191–11205.

Curtis, B. (2002). Foucault on Governmentality and Population: The Impossible Discovery. *The Canadian Journal of Sociology*, *27*(4), 505–533.

Cutler, C.A. (2002). Private Regimes and Interfirm Cooperation. In Hall, R.B. & Biersteker, T.J. (Eds.), *The Emergence of Private Authority in Global Governance*. Cambridge [England]; New York: Cambridge University Press.

Darwin, C., & Endersby, J. (2009). *On the origin of species*. Cambridge, UK; New York: Cambridge University Press.

Dauvergne, P., & Neville, K. J. (2010). Forests, food, and fuel in the tropics: the uneven social and ecological consequences of the emerging political economy of biofuels. *The Journal of Peasant Studies*, *37*(4), 631–660.

Davis, D. H. (1993). *Energy politics*. New York: St. Martin's Press.

Davis v. EPA. 336 F.3d 965 (9th Cir).

Dawson, M. (2015). The Legal and Political Accountability Structure of Post-Crisis EU Economic Governance. *JCMS JCMS: Journal of Common Market Studies*, *53*(5), 976–993.

de Andrade, Renata Marson Teixeira, & Miccolis, Andrew. (2011). *Policies and institutional and legal frameworks in the expansion of Brazilian biofuels*. Center for International Forestry Research.

de Carvalho, Pedro Ninô. (2013). *Government Intervention to Strengthen the Ethanol Sector: Lessons from Brazil* (Evidence and Lessons from Latin America (ELLA) Policy Brief). London: United Kingdom Department for International Development.

De Gorter, H., & Just, D. R. (2010). The social costs and benefits of biofuels : the intersection of environmental, energy and agricultural policy. *Applied Economic Perspectives and Policy*, *32*(1), 4–32.

Dehue, B., Hamelinck, C., Reece, G., de Lint, S., Archer, R., & Garcia, E. (2008). *Sustainability reporting within the RTFO: framework report* (Commissioned by UK Department of Transport). Utrecht, The Netherlands: Ecofys. Retrieved from http://biomass.ucdavis.edu/files/2013/10/10-18-2013-Ecofys-sustainabilityreporting-May07.pdf

Dehue, B., Meyer, S., & Hamelinck, C. (2007). *Towards a harmonised sustainable biomass certification scheme* (Commissioned by WWF). Utrecht: Ecofys Netherlands BV. Retrieved from http://www.exercicescorriges.com/i_339730.pdf

Demetrius, F. J. (1990). *Brazil's national alcohol program : technology and development in an authoritarian regime*. New York: Praeger.

Diemont, W. H., Joosten, H., Mantel, S., Murdiyarso, D., Norrordwijk, van, M., Rieley, J. O., … Limin, S. H. (2001). Poverty alleviation and wise use of peatlands in Indonesia. *International Peat Journal / International Peat Society*, (11), 79–87.

DiMaggio, Paul J., & Powell, Walter W. (1983). The iron cage revisited: Institutional isomorphism and collective rationa lity in organizational fields. *American Sociological Review*, *48*, 147–60.

DiMaggio, Paul J., & Powell, Walter W. (1991). Introduction. In Walter W. Powell and Paul J. DiMaggio (Ed.), *The New Institutionalism in Organization Analysis*. Chicago: University of Chicago Press.

Dingwerth, K. (2008). Private transnational governance and the developing world: A comparative perspective. *International Studies Quarterly*, *52*(3), 607–634.

Djelic, M.-L., & Sahlin-Andersson, K. (2006). *Transnational governance : institutional dynamics of regulation*. Cambridge, UK; New York: Cambridge University Press.

Dobbin, F. (1994). *Forging industrial policy : the United States, Britain, and France in the railway age.* Cambridge [England] ; New York, NY : Cambridge University Press, 1994. Retrieved from http://search.ebscohost.com/login.aspx?direct=true&db=cat04202a&AN=ucb.b11547285&site=eds-live

Dobbin, F. R. (1993). The social construction of the Great Depression: Industrial policy during the 1930s in the United States, Britain, and France. *Theory and Society.*, *22*(1), 1.

Doornbosch, R., & Steenblik, R. (2008). Biofuels: is the cure worse than the disease? *Revista Virtual REDESMA*, *2*, 63.

Dryzek, J. S., & Niemeyer, S. (2010). *Foundations and frontiers of deliberative governance*. Oxford; New York: Oxford University Press.

Dudley, N., Mansourian, S., & Vallauri, D. (2005). Forest landscape restoration in contex. In Mansourian, S., Vallauri, D., & Dudley, N. (Eds.), *Forest Restoration in Landscapes: Beyond Planting Trees* (pp. 3–7). New York, NY: Springer.

Dufey, A., & Grieg-Gran, M. (2010). *Biofuels production, trade and sustainable development*. London: International Institute for Environment and Development. Retrieved from http://www.globalbioenergy.org/uploads/media/1011_IIED_-_Biofuels_production__trade_and_sustainable_development.pdf

DuPuis, E. M. (2002). *Nature's perfect food : how milk became America's drink*. New York: New York University Press.

DuPuis, E. M., & Block, D. (2008). Sustainability and Scale: US Milk-Market Orders as Relocalization Policy. *Environment and Planning A*, *40*(8), 1987–2005. https://doi.org/10.1068/a39250

Earley, J. (2009). *US Trade Policies on Biofuels and Sustainable Development* (Promoting Sustainable Bioenergy Production and Trade) (p. 50). ICTSD International Centre for Trade and Sustainable Development (ICTSD),Programme on Agricultural Trade and Sustainable Development. Retrieved from http://www.globalbioenergy.org/uploads/media/0906_ICTSD_-_US_trade_policies_on_biofuels_and_sustainable_development.pdf

Edel, M. (1969). The Brazilian Sugar Cycle of the Seventeenth Century and the Rise of West Indian Competition. *Caristud Caribbean Studies*, *9*(1), 24–44.

Edwards, Robert, Declan, Mulligan, & Marelli, Luisa. (2010). *Indirect Land Use Change From Increased Biofuels Demand - Comparison of Models and Results for Marginal Biofuels Production from Different Feedstocks* (EUR - Scientific and Technical Research Reports). European Union Joint Research Centre (JRC). Retrieved from http://publications.jrc.ec.europa.eu/repository/handle/JRC59771

Eisen, J. B. (2011). China's Greentech Programs and the USTR Investigation. *Sustainable Development Law & Policy*, *3*(2), 3.

Eisinger, Peter K. (1988). *The Rise of the Entrepreneurial State: State and Local Economic Development Policy in the United States*. Madison, WI: The University of Wisconsin Press.

Elghali, L., Clift, R., Sinclair, P., Panoutsou, C., & Bauen, A. (2007). Developing a sustainability framework for the assessment of bioenergy systems. *Energy Policy*, *35*(12), 6075–6083. https://doi.org/10.1016/j.enpol.2007.08.036

Elkinds, David J., & Richard E. B. Simeon. (1979). A Cause in Search of Its Effect, or What Does Political Culture Explain? *Comparative Politics*, *11*(2). Retrieved from

http://www.la.utexas.edu/users/chenry/core/Course%20Materials/ElkinsCPol1979/0.pdf

Erixon, F. (2012). *The rising trend of green protectionism: biofuels and the European Union* (ECIPE Occasional Paper). European Centre for International Political Economy. Retrieved from http://www.ecipe.org/app/uploads/2014/12/OCC22012.pdf

Erixon, Fredrik. (2009). *Green protectionism in the EU: How Europe's biofuels policy and Renewable Energy Directive violate WTO Commitments* (No. ECIPE Occasional Paper No. 1/200). Brussels: European Centre for International Political Economy.

Etzkowitz, H. (2003). Innovation in innovation: The triple helix of university-industry-government relations. *Social Science Information*, *42*(3), 293–337.

Etzkowitz, H., Ranga, M., Benner, M., Guaranys, L., Maculan, A.-M., & Kneller, R. (2008). Pathways to the entrepreneurial university: towards a global convergence. *Science & Public Policy (SPP)*, *35*(9).

EU (European Union) Council. (2006, June 8). Council Conclusions on Biomass, 2735th TRANSPORT, TELECOMMUNICATIONS and ENERGY Council meeting, Luxembourg. Retrieved August 15, 2017, from http://www.consilium.europa.eu/uedocs/cms_Data/docs/pressdata/en/trans/89933.pdf

European Commission. (2013). Final Guidance Document for the EU Timber Regulation. Retrieved from http://ec.europa.eu/environment/forests/pdf/Final%20Guidance%20document.pdf

European Parliament External Relations Press Release. (2007, July 5). Brazil's President Lula on trade, agriculture, poverty and biofuels. Retrieved from http://www.europarl.europa.eu/sides/getDoc.do?language=en&type=IMPRESS&reference=20070703STO08738

Evans, P. B. (1974). The military, the multinationals and the miracle: The political economy of the brazilian model of development. *St Comp Int Dev Studies in Comparative International Development*, *9*(3), 26–45.

Evans, P. B. (1979). *Dependent development : the alliance of multinational, state, and local capital in Brazil*. Princeton, N.J.: Princeton University Press.

Evans, P. B. (1995). *Embedded autonomy : states and industrial transformation*. Princeton, N.J.: Princeton University Press.

Falkner, R. (2003). Private Environmental Governance and International Relations: Exploring the Links. *Global Environmental Politics*, *3*(2), 72–87.

Fankhauser, S., Bowen, A., Calel, R., Dechezleprêtre, A., Grover, D., Rydge, J., & Sato, M. (2013). Who will win the green race? In search of environmental competitiveness and innovation. *Global Environmental Change*, *23*, 902–913.

FAO (Food and Agriculture Organization). (2008). *THE STATE OF FOOD AND AGRICULTURE*. Rome: United Nations Food and Agriculture Organization. Retrieved from http://www.fao.org/3/a-i0100e.pdf

FAO (Food and Agriculture Organization) / UNECE (Economic Commission for Europe). (2014). *Forest Products Annual Market Review 2013-2014*.

Fargione, J. E., Plevin, R. J., & Hill, J. D. (2010). The Ecological Impact of Biofuels. *Annual Review of Ecology, Evolution, and Systematics.*, *41*, 351.

Fargione J, Hill J, Tilman D, Polasky S, & Hawthorne P. (2008). Land clearing and the biofuel carbon debt. *Science (New York, N.Y.)*, *319*(5867), 1235–8.

Fargione, J., & Searchinger, T. D. (2008). Biofuels: Effects on Land and Fire: Response. *SCIENCE -NEW YORK THEN WASHINGTON-*, *321*(5886), 199.

Farrell AE, Plevin RJ, Turner BT, Jones AD, O'Hare M, & Kammen DM. (2006). Ethanol can contribute to energy and environmental goals. *Science (New York, N.Y.)*, *311*(5760), 506–8.

Farrell, AE, & Sperling, Daniel. (2007). *A Low-Carbon Fuel Standard for California, Part 2: Policy Analysis* (No. RESEARCH REPORT UCB-ITS-TSRC-RR-2007-2). Transportation Sustainabiliyt Research Center. Retrieved from http://www.energy.ca.gov/low_carbon_fuel_standard/UC_LCFS_study_Part_2-FINAL.pdf

Feldman, R. D., Allison, J. E., Dean, N. L., Finkelstein, J. G., Goodwin, L. M., Blair, T. L., … Tundermann, D. (1982). ALTERNATE ENERGY SOURCES COMMITTEE. *Natural Resources Lawyer*, *15*(1), 65–137. https://doi.org/10.2307/40922708

Feldman, Stanley, & Zaller, John. (1992). The Political Culture of Ambivalence: Ideological Responses to the Welfare State. *American Journal of Political Science*, *36*, 268–307.

Ferguson, J. (1994). *The anti-politics machine : "development," depoliticization, and bureaucratic power in Lesotho*. University of Minnesota Press, Minneapolis. Retrieved from /z-wcorg/.

Field, A. J. (2011). *A great leap forward : 1930s Depression and U.S. economic growth*. New Haven: Yale University Press.

Fieldman, G. (2011). Neoliberalism, the production of vulnerability and the hobbled state: Systemic barriers to climate adaptation. *Climate and Development*, *3*(2), 159–174.

Filip, B. (2012). Polanyi and Hayek on Freedom, the State, and Economics. *International Journal of Political Economy*, *41*(4).

Fine, S. (1978). *Laissez faire and the general-welfare state : a study of conflict in American thought, 1865-1901*. Ann Arbor: University of Michigan Press.

Finegold, K., & Skocpol, T. (1995). *State and party in America's New Deal*. Madison: University of Wisconsin Press.

Fischer, C. S. (2010). *Made in America : a social history of American culture and character*. Chicago; London: The University of Chicago Press.

Fligstein, N. (1990). *The transformation of corporate control*. Cambridge, Mass.: Harvard University Press.

FOE (Friends of the Earth). (2002). *Briefing: Earth Summit from Rio to Johannesburg*. Retrieved from https://www.foe.co.uk/sites/default/files/downloads/earth_summit.pdf

Foucault, M. (1984). Nietzsche, genealogy, history. In Rabinow, Paul (Ed.), *The Foucault Reader*. New York: Pantheon.

Foucault, M. (1989). *Foucault live : (interviews, 1966-84)*. (S. Lotringer, Ed.). New York: Semiotext(e).

Foucault, M. (1995). *Discipline and punish : the birth of the prison*. New York: Vintage Books.

Foucault, M., Burchell, G., Gordon, C., & Miller, P. (1991). *The Foucault effect : studies in governmentality : with two lectures by and an interview with Michel Foucault*. Chicago: University of Chicago Press.

Fourcade-Gourinchas, M., & Babb, S. (2003). The rebirth of the liberal creed: paths to neoliberalism in four countries. *Peace Research Abstracts*, *40*(5).

Francis G. Tanczos. (2011). A NEW CRIME: POSSESSION OF WOOD--REMEDYING THE DUE CARE DOUBLE STANDARD OF THE REVISED LACEY ACT. *Rutgers L. J.*, *42*, 549–1175.

French, J. D. (2004). *Drowning in laws : labor law and Brazilian political culture*. Chapel Hill: University of North Carolina Press.

Furtado, A. T., Scandiffio, M. I. G., & Cortez, L. A. B. (2011). The Brazilian sugarcane innovation system. *JEPO Energy Policy*, *39*(1), 156–166.

Gale, F. P. (1998). *The tropical timber trade regime*. New York: St. Martin's Press.

Galor, O., & Moav, O. (2001). NATURAL SELECTION AND THE ORIGIN OF ECONOMIC GROWTH. *Discussion Paper /*, (2727), ALL.

Garcia-Johnson, R. (2000). *Exporting environmentalism : U.S. multinational chemical corporations in Brazil and Mexico*. Cambridge, Ma.: MIT Press.

Gardner, B. (2007). Fuel Ethanol Subsidies and Farm Price Support. *Journal of Agricultural & Food Industrial Organization*, *5*(1).

Garland, D. (2014). What is a history of the present? On Foucaults genealogies and their critical preconditions. *Punishment & Society Punishment & Society*, *16*(4), 365–384.

Gayon, J. (2011). Economic Natural Selection: What Concept of Selection? *Biol Theory Biological Theory*, *6*(4), 320–325.

Gereffi, G., Humphrey, J., & Sturgeon, T. (2005). The governance of global value chains. *Review of International Political Economy*, *12*(1), 78–104.

Gillon, S. (2010). Fields of dreams: negotiating an ethanol agenda in the Midwest United States. *The Journal of Peasant Studies*, *37*(4), 723–748. https://doi.org/10.1080/03066150.2010.512456

Goetzl, A., & Ekström, H.C. (2007). *Report on the review of the US market for tropical timber products*. Port Morseby, Papua New Guinea: International tropical Timber Organization, Committee on Economic Information and Market Intelligence.

Goldemberg, J., Coelho, S. T., & Guardabassi, P. (2008). The sustainability of ethanol production from sugarcane. *JEPO Energy Policy*, *36*(6), 2086–2097.

Goldemberg, J., Coelho, S. T., Nastari, P. M., & Lucon, O. (2004). Ethanol learning curvethe Brazilian experience. *JBB Biomass and Bioenergy*, *26*(3), 301–304.

Goldemberg, J., & Macedo, I. C. (1994). Brazilian alcohol program: an overview. *ESD Energy*

for Sustainable Development, *1*(1), 17–22.

Gordon-Ashworth, F. (1980). Agricultural Commodity Control under Vargas in Brazil, 1930--1945. *Journal of Latin American Studies*, *12*(1), 87–105.

Graham, O. L. (1992). *Losing time : the industrial policy debate.* Cambridge, Mass. : Harvard University Press, 1992. Retrieved from http://search.ebscohost.com/login.aspx?direct=true&db=cat04202a&AN=ucb.b15446366&site=eds-live

Granco, G., Caldas, M. M., Bergtold, J. S., & SantAnna, A. C. (2017). Exploring the policy and social factors fueling the expansion and shift of sugarcane production in the Brazilian Cerrado. *GeoJournal GeoJournal : Spatially Integrated Social Sciences and Humanities*, *82*(1), 63–80.

Greene, T. W. (2008). Three Ideologies of Individualism: Toward Assimilating a Theory of Individualisms and their Consequences. *Critical Sociology*, *34*(1), 117–137. https://doi.org/10.1177/0896920507084628

Gulbrandsen, L. H. (2008). Accountability Arrangements in Non-State Standards Organizations: Instrumental Design and Imitation. *Organization*, *15*(4), 563–583. https://doi.org/10.1177/1350508408091007

Gulbrandsen, L. H. (2014). Dynamic governance interactions: Evolutionary effects of state responses to non-state certification programs: Dynamic governance interactions. *Regulation & Governance*, *8*(1), 74–92. https://doi.org/10.1111/rego.12005

Gutierrez, Maria. (2007). *ALL THAT IS AIR TURNS SOLID: THE CREATION OF A MARKET FOR SINKS UNDER THE KYOTO PROTOCOL ON CLIMATE CHANGE* (Dissertation). The City University of New York, New York, NY.

Haas, P. M. (2004). Science Policy for Multilateral Environmental Governance. *Emerging Forces in Environmental Governance Emerging Forces in Environmental Governance / Ed. by Norichika Kanie and Peter M. Haas, ISBN 9280810952*, 115–136.

Hall, DO, Rosillo-Calle, F, Senelwa, AK, & Woods, J. (1993). Biomass for Energy: supply prospects. In T. B. Johansson & L. Burnham (Eds.), *Renewable energy : sources for fuels and electricity*. Washington, D.C.: Island Press.

Hall, J., Matos, S., Severino, L., & Beltrão, N. (2009). Brazilian biofuels and social exclusion: established and concentrated ethanol versus emerging and dispersed biodiesel. *Journal of Cleaner Production*, *17*, S77–S85. https://doi.org/10.1016/j.jclepro.2009.01.003

Hall, P. A., Social Science Research Council (U.S.)., & Committee on States and Social Structures. (1989). *The Political power of economic ideas : Keynesianism across nations*. Princeton, N.J.: Princeton University Press.

Hall, P. A., & Soskice, D. W. (2001). *Varieties of capitalism : the institutional foundations of comparative advantage*. Oxford [England]; New York: Oxford University Press.

Haque, Irfan ul. (2007). *Rethinking Industrial Policy* (UNCTAD/OSG/DP/2007/2 No. 183). Retrieved from http://unctad.org/en/docs/osgdp20072_en.pdf

Harris NL, Brown S, Hagen SC, Saatchi SS, Petrova S, Salas W, … Lotsch A. (2012). Baseline

map of carbon emissions from deforestation in tropical regions. *Science (New York, N.Y.)*, *336*(6088), 1573–6.

Harvey, D. (2005). *A brief history of neoliberalism*. New York: Oxford University Press.

Harvey, D. (2013). Rebel cities : from the right to the city to the urban revolution. Retrieved from http://hdl.handle.net/2027/heb.32147

Harvey, F., & correspondent, environment. (2014, September 5). EU under pressure to allow GM food imports from US and Canada. *The Guardian*. Retrieved from http://www.theguardian.com/environment/2014/sep/05/eu-gm-food-imports-us-canada

HCV Network. (2015). Welcome to the HCV Resource Network — HCV Resource Network. Retrieved August 15, 2017, from https://www.hcvnetwork.org/about-hcvf

Henke, C. (2008). *Cultivating science, harvesting power : science and industrial agriculture in California*. Cambridge, Mass.: MIT Press.

Hill, Joshua S. (n.d.). Germany Confirms End To Renewable Energy Feed-in Tariffs. Retrieved from https://cleantechnica.com/2016/07/12/germany-confirms-end-renewable-energy-feed-tariffs/

Hochstetler, Kathryn, & Montero, Alfred P. (2012). Inertial Statism and the New Developmentalist State in Brazil. Presented at the Latin American Studies Association, San Francisco, CA.

Hodgson, G. M. (2002). Darwinism in economics: from analogy to ontology. *J Evol Econ Journal of Evolutionary Economics*, *12*(3), 259–281.

Holdren, JP. (1997). *Federal Energy Research and Development for the Challenges of the 21st Century* (President's Committee of Advisors on Science and Technology, Panel of Energy Research and Development, Report for Office of Science and Technology Policy, Executive Office of the President of the United States). Washington, D.C.: Executive Office of the President of the United States.

Holmes, S. (1995). *Passions and constraint : on the theory of liberal democracy*. Chicago: University of Chicago Press.

Holt-Giménez, Eric. (2007). Exploding the Biofuel Myths : Food First. Retrieved August 15, 2017, from https://foodfirst.org/exploding-the-biofuel-myths/

Hoogwijk, M., Faaij, A., van den Broek, R., Berndes, G., Gielen, D., & Turkenburg, W. (2003). Exploration of the ranges of the global potential of biomass for energy. *JBB Biomass and Bioenergy*, *25*(2), 119–133.

Hooijer, A, Page, S., Canadell, J. G., Silvius, M, Kwadijk, J., Wösten, H., & Jauhiainen, J. (2010). Current and future CO2 emissions from drained peatlands in Southeast Asia. *Biogeosciences*, *7*, 1505–1514.

Hoover, H. (1922). *American individualism*.

Hoover, H. (1934). *The state papers and other public writings of Herbert Hoover*. (W. S. Myers, Ed.). Garden City, N.Y.: Doubleday, Doran & Co.

Hovenkamp, H. (1991). *Enterprise and American law, 1836-1937*. Cambridge, Mass.: Harvard University Press.

Huesemann, M., & Huesemann, J. (2011). *Techno-fix : why technology won't save us or the environment.* Gabriola Island, B.C. : New Society Publishers, c2011. Retrieved from http://search.ebscohost.com/login.aspx?direct=true&db=cat04202a&AN=ucb.b19070525&site=eds-live

Hughes, T. P. (1983). *Networks of power : electrification in Western society, 1880-1930*. Baltimore, Maryland: Johns Hopkins University Press.

Humphreys, D. (1996). The global politics of forest conservation since the unced. *Environmental Politics*, *5*(2), 231–257.

Humphreys, D. (2009). Discourse as ideology: Neoliberalism and the limits of international forest policy. *Forest Policy and Economics*, *11*(5–6), 319–325. https://doi.org/10.1016/j.forpol.2008.08.008

Hunt, E. K. (2003). *Property and prophets : the evolution of economic institutions and ideologies*. Armonk, N.Y.: M.E. Sharpe.

Hurst, J. W. (1984). Law and the conditions of freedom in the nineteenth-century United States. Retrieved from http://hdl.handle.net/2027/heb.07883

Intergovernmental Panel on Climate Change (IPCC). (2007). *Climate Change 2007: Synthesis Report. Contribution of Working Groups I, II and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change* (p. 104). Retrieved from https://ipcc.ch/pdf/assessment-report/ar4/syr/ar4_syr_frontmatter.pdf

International Energy Agency. (2011). *World Energy Outlook, 2011*. Retrieved from https://www.iea.org/publications/freepublications/publication/WEO2011_WEB.pdf

ISO (International Standards Organization). (2015). ISO 13065:2015 - Sustainability criteria for bioenergy. Retrieved August 15, 2017, from https://www.iso.org/standard/52528.html

IUCN (International Union for Conservation of Nature). (2007). CURRENT KNOWLEDGE OF THE IMPACTS OF GENETICALLY MODIFIED ORGANISMS ON BIODIVERSITY AND HUMAN HEALTH: AN INFORMATION PAPER. Retrieved August 15, 2017, from https://cmsdata.iucn.org/downloads/ip_gmo_09_2007_1_.pdf

Jardim, Fabiana. (2013). A brief genealogy of governmentality studies: the Foucault effect and its developments. An interview with Colin Gordon. *Educação e Pesquisa*, *29*(4).

Jasanoff, S. (2006). *States of knowledge : the co-production of science and the social order*. London: Routledge.

Jasanoff, S., & Kim, S.-H. (2009). Containing the Atom: Sociotechnical Imaginaries and Nuclear Power in the United States and South Korea. *Minerva Minerva : A Review of Science, Learning and Policy*, *47*(2), 119–146.

Jasanoff, S., & Kim, S.-H. (2015). *Dreamscapes of modernity : sociotechnical imaginaries and the fabrication of power*. Chicago; London: University of Chicago Press.

Jepson, W., Brannstrom, C., & Filippi, A. (2009). Access Regimes and Regional Land Change in the Brazilian Cerrado, 1972-2002. *Annals of the Association of American Geographers*, *100*(1), 87–111.

Jessop, B. (2002). *The future of the capitalist state*. Cambridge, UK; Malden, MA: Polity ;

Distributed in the USA by Blackwell Pub.

Jessop, B. (2010). Cultural political economy and critical policy studies. *Critical Policy Studies*, *3*(3–4), 336–356.

Jessop, B. (2017). Varieties of academic capitalism and entrepreneurial universities : On past research and three thought experiments. *High Educ Higher Education : The International Journal of Higher Education Research*, *73*(6), 853–870.

João, I. d S., Porto, G. S., & Galina, S. V. R. (2011). The position of Brazil on the run for cellulosic ethanol: Mensuration by S amp;T and R amp;D programs. In *2011 Proceedings of PICMET '11: Technology Management in the Energy Smart World (PICMET)* (pp. 1–9).

Johnson, C. (1982). *MITI and the Japanese miracle : the growth of industrial policy, 1925-1975*. Stanford, Calif. : Stanford University Press, 1982. Retrieved from http://search.ebscohost.com/login.aspx?direct=true&db=cat04202a&AN=ucb.b12879924&site=eds-live

Johnson, F. I. (1983). Sugar in Brazil: Policy and Production. *Journal of Developing Areas*, *17*(2), 243–256.

Johnson, J. (1988, July 17). The Drought of '88; Candidates Gauge the Implications Of the Heartland's Dry Summer. *The New York Times*. Retrieved from http://www.nytimes.com/1988/07/17/weekinreview/nation-drought-88-candidates-gauge-implications-heartland-s-dry-summer.html

Johnson, N., & B. Cabarle. (1993). *Surviving the Cut: Natural Forest Management in the Humid Tropics*. Washington, D.C.: World Resources Institute.

Jon Hutton, M. A. (2010). *Food Security, Biofuels and Agriculture: Major Drivers of Biodiversity Loss and an Opportunity for Sustainability?* (DRAFT White paper). Retrieved from https://www.macfound.org/media/files/CSD_AGRICULTURE_WHITE_PAPER.pdf

Jones, C. F. (2014). Routes of power : energy and modern America. Retrieved from http://public.eblib.com/choice/publicfullrecord.aspx?p=3301458

Junginger, M., De Wit, M., Sikkema, R., & Faaij, A. (2007). *International bioenergy trade in the Netherlands, special IEA Bioenergy Task 40 issue of Biomass and Bioenergy*. International Energy Agency.

Karp, L., & Stevenson, M. (2012). Green Industrial policy: trade and theory. *CUDARE Working Paper Series*. Retrieved from http://search.ebscohost.com/login.aspx?direct=true&db=edsrep&AN=edsrep.p.are.cudare.1126&site=eds-live

Kasahara Y., Kasahara Y., & Botelho A.J.J. (2016). Catching up and falling behind: An appraisal of Brazilian industrial policy in the twenty-first century. *Eur. Rev. Lat. Am. Caribb. Stud. European Review of Latin American and Caribbean Studies*, *101*, 97–109.

Kathryn Hochstetler, & Alfred P. Montero. (2013). The Renewed Developmental State: The National Development Bank and the Brazil Model. *Journal of Development Studies*, *49*(11), 1484–1499.

Kaup, F. (2015). The sugarcane complex in Brazil : the role of innovation in a dynamic sector on its path towards sustainability. Retrieved from http://public.eblib.com/choice/publicfullrecord.aspx?p=2096858

Keck, M. E., & Sikkink, K. (1998). *Activists beyond borders : advocacy networks in international politics*. Ithaca, N.Y.: Cornell University Press.

KEENEY, D. (2009). Ethanol USA. *Environmental Science & Technology*, *43*(1).

Keller, A. C. (2009). *Science in environmental policy : the politics of objective advice*. Cambridge, Mass.: MIT Press.

Kennedy, John F. (1962, June). *Commencement Address at Yale University.* Yale University, New Have, CT. Retrieved from http://www.presidency.ucsb.edu/ws/?pid=29661

Keohane, R. O. (2005). *After hegemony : cooperation and discord in the world political economy*. Princeton, N.J.: Princeton University Press.

Keohane, R. O., & Victor, D. G. (2011). The Regime Complex for Climate Change. *Persp on Pol Perspectives on Politics*, *9*(01), 7–23.

Keynes, John Maynard. (1933). An Open Letter to President Roosevelt. Retrieved from http://newdeal.feri.org/misc/keynes2.htm

Kleinman, D. L. (1995). *Politics on the endless frontier : postwar research policy in the United States*. Durham: Duke University Press.

Kløverpris, Jesper, Wenzel, Henrik, & Nielsen, Per H. (2008). Life cycle inventory modelling of land use induced by crop consumption - Part 1: Conceptual analysis and methodological proposal. *International Journal of Life Cycle Analysis*, *13*(1), 13–21.

Kohler, Pia M., Conliffe, Alexandra, Jungcurt, Stefan, Gutierrez, Maria, & Yamineva, Yulia. (n.d.). Informing Policy: Science and Knowledge in Global Environmental Agreements. In Chasek, P. S. & Wagner, L.M. (Eds.), *The Roads from Rio: Lessons Learned from Twenty Years of Multilateral Environmental Negotiations* (pp. 59–81). New York, NY: RFF Press, Taylor and Francis.

Kojima, M., & Johnson, T. (2005). *Potential for Biofuels for Transport in Developing Countries*. Washington, D.C.: International Bank for Reconstruction and Development/The World Bank, Energy Sector Management Assistance Programme (ESMAP). Retrieved from https://openknowledge.worldbank.org/handle/10986/20309

Kuhn, T. S. (1996). *The structure of scientific revolutions*. Chicago, IL: University of Chicago Press.

Kurtz, M. J., & Brooks, S. M. (2008). Embedding Neoliberal Reform in Latin America. *wp World Politics*, *60*(2), 231–280.

Laceyduecare.com. (2012, May 22). National Consensus Lacey Due Care Standard Unanimously Approved. Retrieved August 15, 2017, from http://www.laceyduecare.com/Press_Release_on_Unanimous_Approval_2.pdf

Lal, R. (2006). Enhancing crop yields in the developing countries through restoration of the soil organic carbon pool in agricultural lands. *LDR Land Degradation & Development*, *17*(2), 197–209.

Lane, Jim. (n.d.). An Institute of Industrial Commercialization : Biofuels Digest. Retrieved from http://www.biofuelsdigest.com/bdigest/2012/05/08/an-institute-of-industrial-commercialization/

Lazzari, S. (2007). *Energy tax policy: History and current issues*. Congressional Research Service.

Lemos, M. C., & Agrawal, A. (2006). Environmental governance. *Annual Review of Environment and Resources*.

Leonard, T. C. (2009). American Economic Reform in the Progressive Era: Its Foundational Beliefs and Their Relation to Eugenics. *History of Political Economy*, *41*(1), 109–141. https://doi.org/10.1215/00182702-2008-040

Leonard, T. C. (2011). Religion and Evolution in Progressive Era Political Economy: Adversaries or Allies? *History of Political Economy*, *43*(3), 429–469. https://doi.org/10.1215/00182702-1346815

Leonard, T. C. (2015). Progressive Era Origins of the Regulatory State and the Economist as Expert. *History of Political Economy.*, *47*, 49–76.

Lerner, A. P. (1983). *Selected economic writings of Abba P. Lerner*. (D. C. Colander, Ed.). New York: New York University Press.

Levidow L., & Papaioannou T. (2014). UK biofuel policy: Envisaging sustainable biofuels, shaping institutions and futures. *Environ. Plann. A Environment and Planning A*, *46*(2), 280–298.

Levy, D. L., & Newell, P. (2005). *The business of global environmental governance*. Cambridge, Mass.: MIT Press.

Lewandowski, I., & Faaij, A. (2006). Steps towards the development of a certification system for sustainable bio-energy trade. *Biomass and Bioenergy*, *30*(2), 83–104. https://doi.org/10.1016/j.biombioe.2005.11.003

Lewis, K. E. (2014). *Analysis of the United States' Sugar Industry*. Arizona State University. Retrieved from http://search.proquest.com/openview/ca1e3469f93f8226b8518c198e481a41/1?pq-origsite=gscholar&cbl=18750&diss=y

Libecap, Gary. (2003). Agricultural Programs with Dubious Environmental Benefits: The Political Economy of Ethanol. In R. E. Meiners & B. Yandle (Eds.), *Agricultural policy and the environment*. Lanham, MD: Rowan & Littlefield Publishers.

Lichbach, M. I., & Zuckerman, A. S. (1997). *Comparative politics : rationality, culture, and structure*. Cambridge, UK: Cambridge University Press. Retrieved from http://site.ebrary.com/id/10277520

Lindblom, C. E. (1965). *The intelligence of democracy : decision making through mutual adjustment*. New York: Free Press.

Lipset, S. M. (1979). *The first new nation : the United States in historical and comparative perspective*. New York: Norton.

Lipset, S. M. (1988). *Revolution and counterrevolution : change and persistence in social*

structures. New Brunswick, N.J.: Transaction Books.

Lipset, S. M. (1996). *American exceptionalism : a double-edged sword*. New York: W.W. Norton.

London, J., Karner, A., Sze, J., Rowan, D., Gambirazzio, G., & Niemeier, D. (2013). Racing climate change: Collaboration and conflict in California's global climate change policy arena. *Global Environmental Change*, *23*(4), 791–799. https://doi.org/10.1016/j.gloenvcha.2013.03.001

Lounsbury, M., Ventresca, M., & Hirsch, P. M. (2003). Social movements, field frames and industry emergence: a cultural-political perspective on US recycling. *Socio-Economic Review*, *1*(1), 71–104.

Lynd LR, Laser MS, Bransby D, Dale BE, Davison B, Hamilton R, … Wyman CE. (2008). How biotech can transform biofuels. *Nature Biotechnology*, *26*(2), 169–72.

MacKenzie, D. A. (2006). An engine, not a camera : how financial models shape markets. Retrieved from http://www.books24x7.com/marc.asp?bookid=12932

Malczewski, J. (2013). Philanthropy and Progressive Era State Building through Agricultural Extension Work in the Jim Crow South. *History of Education Quarterly*, *53*(4).

March, J. G., & Olsen, J. P. (1989). *Rediscovering institutions : the organizational basis of politics*. New York: The Free Press.

Martineau, Robert J., & Novello, David P. (2004). *The Clean Air Act Handbook* (2nd ed.). American Bar Association.

Martinelli, L. A., BALBAUD OMETTO, J. P. H., FILOSO, S., & VICTORIA, R. L. (2010). Contextualizing ethanol avoided carbon emissions in Brazil. *GCBB GCB Bioenergy*, *2*(3), 152–156.

Masum, B. M., Masjuki, H. H., Kalam, M. A., Rizwanul Fattah, I. M., Palash, S. M., & Abedin, M. J. (2013). Effect of ethanolgasoline blend on NOx emission in SI engine. *Renewable and Sustainable Energy Reviews Renewable and Sustainable Energy Reviews*, *24*(3), 209–222.

Matthews *, K., & Paterson, M. (2005). Boom or bust? the economic engine behind the drive for climate change policy. *Global Change, Peace & Security Global Change, Peace & Security*, *17*(1), 59–75.

Mayr, E. (1991). *One long argument : Charles Darwin and the genesis of modern evolutionary thought*. Cambridge, Mass.: Harvard University Press.

McClanahan, Paige. (2010). The Lacey Act: Timber trade enforcement gets some teeth. *BIORES*, *4*. Retrieved from https://www.ictsd.org/bridges-news/biores/news/the-lacey-act-timber-trade-enforcement-gets-some-teeth

McCloskey, Deirdre N. (1997). Other things equal: The rhetoric of economics, revisited. *Eastern Economic Journal*, *23*(3), 359.

McDonough, P. (1981). *Power and ideology in Brazil*. Princeton, N.J.: Princeton University Press.

McNichol, Jason Hall. (2002, December). *Contesting Governance in the Global Marketplace: A*

Sociological Assessment of Business-NGO Partnerships to Build Markets for Certified Wood. Dissertation, University of California, Berkeley.

Meidinger, E. (2003). *Social and political dimensions of forest certification*. Remagen-Oberwinter: Kessel.

Meidinger, E. (2006). The Administrative Law of Global Private-Public Regulation : the Case of Forestry. *European Journal of International Law European Journal of International Law*, *17*(1), 47–88.

Meidinger, E. (2011). Forest certification and democracy. *European Journal of Forest Research*, *130*(3), 407–419.

Mello, F.F.C., Cerri C.C., Mello F.F.C., Holbrook N.M., Cerri C.E.P., Davies C.A., … Bernoux M. (2014). Payback time for soil carbon and sugar-cane ethanol. *Nat. Clim. Change Nature Climate Change*, *4*(7), 605–609.

Meyer, D. S., & Tarrow, S. G. (1998). A movement society: Contentious politics for a new Century (pp. 1–28),. In Meyer, David S. & Tarrow, Sidney G. (Eds.), *The Social Movement Society* (pp. 1–28). Lanham: Rowman & Littlefield Publishers.

Mill, J. S., & Nathanson, S. (2004). *Principles of political economy : with some of their applications to social philosophy*. Indianapolis: Hackett Pub.

Mitchell, D. (2008). *A Note on Rising Food Prices* (Policy Research Working Paper No. 4682). Washington, D.C.: World Bank, Development Prospects Group,.

Mitchell, T. (1988). *Colonising Egypt*. Berkeley, CA: University of California Press. Retrieved from http://site.ebrary.com/id/10533553

Mitchell, T. (2012). *Carbon democracy : political power in the age of oil*. London: Verso.

Molina, O., & Rhodes, M. (2002). CORPORATISM: The Past, Present, and Future of a Concept. *Annual Review of Political Science*, *5*(1).

Monbiot, George. (2007). An Agricultural Crime Against Humanity. Retrieved from http://www.monbiot.com/2007/11/06/an-agricultural-crime-against-humanity/

Montefrio, M. J. F. (2012). Privileged biofuels, marginalized indigenous peoples: The coevolution of biofuels development in the tropics. *Bulletin of Science, Technology & Society*, *32*(1), 41–55.

Moreira, J. R., & Goldemberg, J. (1999). The alcohol program. *Energy Policy*, *27*(4), 229–245.

Morgan, I. (2004). Jimmy Carter, Bill Clinton, and the New Democratic Economics. *Historicalj The Historical Journal*, *47*(4), 1015–1039.

Mulvaney, D. (2014). Are green jobs just jobs? Cadmium narratives in the life cycle of Photovoltaics. *Geoforum*, *54*, 178–186. https://doi.org/10.1016/j.geoforum.2014.01.014

Murphy, H., & Kellow, A. (2013). Forum Shopping in Global Governance: Understanding States, Business and NGOs in Multiple Arenas. *Global Policy*, *4*(2), 139–149.

Muthu, S. (2008). Adam Smith's Critique of International Trading Companies: Theorizing "Globalization" in the Age of Enlightenment. *Political Theory*, *36*(2), 185–212. https://doi.org/10.1177/0090591707312430

Nascimento, P.T., Lima, N. C., Nigro, F., Quinello, R., S. Macri Russo, R. de F., Sin Oih Yu, A., & Tromboni de Souza Nascimento, P. (2009). Exogenous Factors in the Development of Flexible Fuel Cars as a Local Dominant Technology. *Jotmi Journal of Technology Management & Innovation*, *4*(4), 110–119.

National Academy of Sciences Commission on Life Sciences. (2000). *Biobased Industrial Products: Research and Commercialization Priorities*. Washington, D.C.: National Academies Press.

National Academy of Sciences, National Research Council, & National Academy of Engineering. (2009). *America's Energy Future: Technology and Transformation*. Washington, D.C.: National Academies Press.

National Research Council, Commission on Engineering and Technical Systems (CETS). (1999). *Review of the Research Strategy for Biomass-Derived Transportation Fuels*. Washington, D.C.: National Academies Press.

National Research Council, Commission on Engineering and Technical Systems (CETS). (2000). *Biobased industrial products, priorities for research and commercialization*. Washington, D.C.: National Academies Press.

Naylor, R. L., Liska, A. J., Burke, M. B., Falcon, W. P., Gaskell, J. C., Rozelle, S. D., & Cassman, K. G. (2007). The ripple effect: biofuels, food security, and the environment. *Environment: Science and Policy for Sustainable Development*, *49*(9), 30–43.

Nelson, R. R., & Winter, S. G. (1982). *An evolutionary theory of economic change*. Cambridge, Mass.: Belknap Press of Harvard University Press.

New Fuels Alliance. (2008, October 23). Letter to Mary D. Nichols, Chairmain, California Air Resources Board. Retrieved from http://www.newfuelsalliance.org/ARB_LUC_Final.pdf

Newell, P., & Mulvaney, D. (2013). The political economy of the just transition. *GEOJ The Geographical Journal*, *179*(2), 132–140.

Nixon, Richard. (1973, November 7). Address to the Nation About Policies To Deal With the Energy Shortages. Retrieved August 11, 2017, from http://www.presidency.ucsb.edu/ws/?pid=4034

Normanha, E.S., & Pereira, AS. (n.d.).

Nowotny, H., Scott, P., & Gibbons, M. (2001). *Re-thinking science : knowledge and the public in an age of uncertainty*. Cambridge, UK: Polity.

Nunberg, B. S. (1986). Structural Change and State Policy: The Politics of Sugar in Brazil since 1964. *Latin American Research Review*, *21*(2), 53–92.

Nye, J. S. (2005). On the Rise and Fall of American Soft Power. *NPQ: New Perspectives Quarterly*, *22*(3).

Obama, B. (2009, April 22). Earth Day Speech. Retrieved from http://www.cbsnews.com/news/transcript-obamas-earth-day-speech/

O'Neill, K. (1997). Regulations as arbiters of risk: Great Britain, Germany, and the hazardous waste trade in western... *International Studies Quarterly*, *41*(4).

O'Neill, K. (2000). *Waste trading among rich nations : building a new theory of environmental*

regulation. Cambridge, Mass.: MIT Press.

O'Neill, K. (2013). *The environment and international relations*.

O'Neill, K., Weinthal, E., Marion Suiseeya, K. R., Bernstein, S., Cohn, A., Stone, M. W., & Cashore, B. (2013). Methods and Global Environmental Governance. *Annual Review of Environment and Resources*, *38*(1), 441–471. https://doi.org/10.1146/annurev-environ-072811-114530

Overdevest, C. (2004). Codes of Conduct and Standard Setting in the Forest Sector: Constructing Markets for Democracy? *Relations industrielles*, *59*(1), 172. https://doi.org/10.7202/009131ar

Overdevest, C. (2005). Treadmill Politics, Information Politics, and Public Policy. *Organization & Environment*, *18*(1), 72–90.

Overdevest, C. (2010). Comparing forest certification schemes: the case of ratcheting standards in the forest sector. *Socio-Economic Review*, *8*(1), 47–76.

Overdevest, C., & Zeitlin, J. (2014). Constructing a transnational timber legality assurance regime: Architecture, accomplishments, challenges. *Forest Policy and Economics*, *48*, 6–15.

Pagel, Geovana. (2008). For UN, Brazil‟s Biofuel Model is a Win, Win, Win Strategy. Retrieved from https://www.ictsd.org/i/trade-and-sustainable-development-agenda/34226

Parson, E. A., P. M. Haas, & M. A. Levy. (n.d.). A summary of major documents signed at the earth summit and the global forum. *Environment*, *34*(4), 12–36.

Parthasarathy, S. (2017). *Patent politics : life forms, markets, and the public interest in the United States and Europe*.

Pattberg, P. (2005). The Institutionalization of Private Governance: How Business and Nonprofit Organizations Agree on Transnational Rules. *Governance*, *18*(4), 589–610.

Pattberg, P. (2010). Public-private partnerships in global climate governance. *Wiley Interdisciplinary Reviews: Climate Change*, *1*(March/April), n/a-n/a. https://doi.org/10.1002/wcc.38

Peck, J. (2005). Economic Sociologies in Space. *ECGE Economic Geography*, *81*(2), 129–175.

Peet, R. (2001). Neoliberalism or Democratic Development? *Review of International Political Economy*, (2), 329.

Perlack, R. D., Eaton, L. M., Turhollow Jr, A. F., Langholtz, M. H., Brandt, C. C., Downing, M. E., … others. (2011). US billion-ton update: biomass supply for a bioenergy and bioproducts industry. Retrieved from http://lib.dr.iastate.edu/abe_eng_reports/16/

Pinheiro-Machado R, & De Oliveira PL. (2001). The Brazilian investment in science and technology. *Brazilian Journal of Medical and Biological Research = Revista Brasileira de Pesquisas Medicas e Biologicas*, *34*(12), 1521–30.

Plevin, R. J. (2009). Modeling Corn Ethanol and Climate : A Critical Comparison of the BESS and GREET Models. *JIEC Journal of Industrial Ecology*, *13*(4), 495–507.

Polanyi, K. (2001). *The great transformation : the political and economic origins of our time*.

Boston, MA: Beacon Press.

Polanyi, M. (1958). *Personal knowledge; towards a post-critical philosophy.* Chicago: University of Chicago Press.

Porter, Michael E., & Spence, A. Michael. (n.d.). The Capacity Expansion Process in a Growing Oligopoly: The Case of Corn Wet Milling. In John J. MacCall (Ed.), *The Economics of Information and Uncertainty*. Chicago, IL: U niversity of Chicago Press. Retrieved from http://www.nber.org/books/mcca82-1

Porter, T. M. (1995). *Trust in numbers : the pursuit of objectivity in science and public life*. Princeton, N.J.: Princeton University Press. Retrieved from http://site.ebrary.com/id/10031957

Radford, G. (1996). *Modern housing for America : policy struggles in the New Deal era*. Chicago: University of Chicago Press.

Raustiala, K., & Victor, D. G. (2006). The Regime Complex for Plant Genetic Resources. *International Law and International Relations International Law and International Relations / Ed. by Beth A. Simmons and Richard H. Steinberg, ISBN 0521679915*, 684–709.

Reagan, Ronald. (1981, July 17). Message to the Congress Transmitting the National Energy Policy Plan. Retrieved August 11, 2017, from http://www.presidency.ucsb.edu/ws/?pid=44096#axzz2igr7sl3o

Reagan, Ronald. (1987). *Public Papers of the Presidents of the United States: Ronald Reagan, 1987*.

Reed, I. (2011). *Interpretation and social knowledge : on the use of theory in the human sciences*. Chicago; London: The University of Chicago Press.

Regalado, Antonio. (2010). Race for Cellulosic Fuels Spurs Brazilian Research Program. *Science*, *327*(5968).

Reinicke, W. H., Deng, F. M., Witte, J. M., & International Development Research Centre (Canada). (2000). Critical choices the United Nations, networks, and the future of global governance. Retrieved from http://site.ebrary.com/id/10176415

Reitze, Arnold W. (2001). *Air Pollution Control Law: Compliance and Enforcement*. Wasington, D.C.: The Environmental Law Institute.

Renewable Fuels Association, Growth Energy, Illinois Corn Growers Association, Iowa Corn Growers Association, Minnesota Corn Growers Association, Missouri Corn Growers Association, … Monsanto Corporation. (2010). *Benefits of an Enhanced RFS2 in the Midwestern States*. Retrieved from http://www.ethanolrfa.org/wp-content/uploads/2015/09/Benefits-of-an-Enhanced-RFS2-in-the-Midwest_AIR_2010-06-18.pdf

Renewable Fuesl Association. (2013). Cellulosic Biofuels Industry Progress Report, 2012-2013. Retrieved August 11, 2017, from https://ethanolrfa.3cdn.net/d9d44cd750f32071c6_h2m6vaik3.pdf

RFA (Renewable Fuels Association). (2010, June 24). CORRECTING and REPLACING Study:

With Support from Heartland States, RFS2 Can Accomplish Midwest GHG Reduction Goals. Retrieved from http://www.businesswire.com/news/home/20100623006601/en/CORRECTING-REPLACING-Study-Support-Heartland-States-RFS2

Risse-Kappen, T., Ropp, S. C., & Sikkink, K. (1999). The power of human rights : international norms and domestic change.

Robertson, G. P., Dale, V. H., Doering, O. C., Hamburg, S. P., Melillo, J. M., Wander, M. M., … Wilhelm, W. W. (2008). Sustainable Biofuels Redux. *Science Science*, *322*(5898), 49–50.

Rodrik, D. (2008). *Normalizing industrial policy*. International Bank for Reconstruction and Development/The World Bank. Retrieved from http://213.154.74.164/invenio/record/18465/files/rodrikter.pdf

Rodrik, D. (2009). *One economics, many recipes : globalization, institutions, and economic growth*. Princeton: Princeton University Press.

Rodrik, D. (2014). Green industrial policy. *Oxford Review of Economic Policy*, *30*(3), 469–491. https://doi.org/10.1093/oxrep/gru025

Rogers, T. D. (2015). Agricultural Transformations in Sugarcane and Labor in Brazil. https://doi.org/10.1093/acrefore/9780199366439.013.55

Roosevelt, Franklin D., & Samuel I. Rosenman. (1938). *The Public Papers and Addresses of Franklin D. Roosevelt* (Vols. 1–13). New York: Random House.

Rosenau, J. N. (1993). *Governance without government : order and change in world politics*. Cambridge [u.a.]: Cambridge Univ. Press.

Rosenof, T. (1997). *Economics in the long run : New Deal theorists and their legacies, 1933-1993*. Chapel Hill: University of North Carolina Press.

Rosenthal, E. (2008). Studies Call Biofuels a Greenhouse Threat. *New York Times*, A.9.

Rosenthal, Elisabeth. (2011, April 6). Food Prices Stir Concern About Biofuels Mandates - The New York Times. *The New York Times*. Retrieved from http://www.nytimes.com/2011/04/07/science/earth/07cassava.html

Rosillo-Calle, F., & Cortez, L. A. B. (1998). Towards ProAlcool IIa review of the Brazilian bioethanol programme. *JBB Biomass and Bioenergy*, *14*(2), 115–124.

Rostow, W. W. (1990). *The stages of economic growth : a non-communist manifesto*.

Ruggie, J. G. (2004a). American exceptionalism, exemptionalism and global governance. Retrieved from http://ksgnotes1.harvard.edu/research/wpaper.nsf/rwp/RWP04-006/$File/rwp04_006_Ruggie.pdf

Ruggie, J. G. (2004b). Reconstituting the global public domain : issues, actors and practices. Retrieved from http://ksgnotes1.harvard.edu/research/wpaper.nsf/rwp/RWP04-031/$File/rwp04_031_Ruggie.pdf

Sabel, C. (2012). Dewey, Democracy, and Democratic Experimentalism. *Contemporary Pragmatism*, *9*(2), 35–55.

Sabel, C. F., & Zeitlin, J. (2008). Learning from difference : the new architecture of

experimentalist governance in the European Union. *European Law Journal*, *14*, 278–80.

Sabel, C. F., & Zeitlin, J. (2010). Experimentalist governance in the European Union : towards a new architecture. Retrieved from http://public.eblib.com/choice/publicfullrecord.aspx?p=480648

Sabel, C. F., Zeitlin, J., & others. (2012). Experimentalist governance. *The Oxford Handbook of Governance*, *1*. Retrieved from https://www.researchgate.net/profile/Charles_Sabel/publication/228435683_Experimentalist_Governance/links/00463520ea077a6846000000.pdf

Sabel, Charles, O'Rourke, Dara, & Fung, Archon. (n.d.). Ratcheting Labor Standards: How Open Competition Can Save Ethical Sourcing. In Thamotheram, R. (Ed.), *Visions of Ethical Sourcing*. London: Financial Times Prentice Hall.

Sabel, Charles, & Zeitlin, Jonathan. (2011). Experimentalism in Transnational Governance: Emergent Pathways and Diffusion Mechanisms. Presented at the International Studies Association, Montreal.

Sawyer, D. (2008). Climate Change, Biofuels and Eco-Social Impacts in the Brazilian Amazon and Cerrado. *Philtranbiolscie Philosophical Transactions: Biological Sciences*, *363*(1498), 1747–1752.

Schlegel, S., & Kaphengst, T. (2007). European Union policy on bioenergy and the role of sustainability criteria and certification systems. *Journal of Agricultural & Food Industrial Organization*, *5*(2). Retrieved from https://www.degruyter.com/dg/viewarticle/j$002fjafio.2007.5.2$002fjafio.2007.5.2.1193$002fjafio.2007.5.2.1193.xml

Schmidt, V. A. (2008). Discursive Institutionalism: The Explanatory Power of Ideas and Discourse. *Annual Review of Political Science*, *11*(1).

Schmitz, N. (2007). Certification to ensure sustainable production of biofuels. *BIOT Biotechnology Journal*, *2*(12), 1474–1480.

Schouten, Greetje. (2013). *Tabling Sustainable Commodities through Private Governance: Processes of Legitimization in the Roundtables on Sustainable Palm Oil and Responsible Soy*. Wageningen University, Utrecht, The Netherlands.

Schrank, A., & Kurtz, M. (2005). Credit Where Credit Is Due: Open Economy Industrial Policy and Export Diversification in Latin America and the Caribbean. *Politics & Society*, *33*(4), 671–702.

Schrank, A., & Whitford, J. (2009). Industrial Policy in the United States: A Neo-Polanyian Interpretation. *Politics & Society*, *37*(4), 521–553.

Scott, J. C. (1998). *Seeing like a state : how certain schemes to improve the human condition have failed*. New Haven: Yale University Press.

Scott, Joanne. (2007). *The WTO Agreement on Sanitary and Phytosanitary Measures: A Commentary*. Oxford: Oxford University Press.

Scott, W. R. (2004). Reflections on a Half-Century of Organizational Sociology. *Annu. Rev. Sociol. Annual Review of Sociology*, *30*(1), 1–21.

Searchinger T, Heimlich R, Houghton RA, Dong F, Elobeid A, Fabiosa J, … Yu TH. (2008). Use of U.S. croplands for biofuels increases greenhouse gases through emissions from land-use change. *Science (New York, N.Y.)*, *319*(5867), 1238–40.

Shain, B. A. (1994). *The myth of American individualism : the Protestant origins of American political thought*. Princeton, N.J.: Princeton University Press.

Shenhav, Y. A. (1999). *Manufacturing rationality : the engineering foundations of the managerial revolution*. Oxford; New York: Oxford University Press.

Shonkoff, S. B., Morello-Frosch, R., Pastor, M., & Sadd, J. (2011). The climate gap: environmental health and equity implications of climate change and mitigation policies in California--a review of the literature. *Climatic Change*, *109*(Supplement), 485–503.

Simmons B, et al. (2008, June 24). Memo to California Air Resource Board Chairman Mary Nichols.

Skidmore, T. E. (1988). *The politics of military rule in Brazil, 1964-85*. New York: Oxford University Press.

Sklar, M. J. (1988). *The corporate reconstruction of American capitalism, 1890-1916 : the market, the law, and politics*. Cambridge [Cambridgeshire]; New York: Cambridge University Press.

Skocpol, T. (1995). *Social policy in the United States : future possibilities in historical perspective*. Princeton, N.J.: Princeton University Press.

Skocpol, T., & Finegold, K. (1982). State Capacity and Economic Intervention in the Early New Deal. *Political Science Quarterly*, *97*(2), 255. https://doi.org/10.2307/2149478

Slaughter, A.-M. (2004). *A new world order*. Princeton: Princeton University Press.

Smith, A. (1759). *The theory of moral sentiments. : By Adam Smith, Professor of Moral Philosophy in the University of Glasgow.* London: Printed for A. Millar, in the Strand, And A. Kincaid and J. Bell, in Edinburgh. Retrieved from http://find.galegroup.com/ecco/infomark.do?contentSet=ECCOArticles&docType=ECCOArticles&bookId=0473300100&type=getFullCitation&tabID=T001&prodId=ECCO&docLevel=TEXT_GRAPHICS&version=1.0&source=library

Smith, A. (2009). *Adam Smith's The wealth of nations : a modern-day interpretation of an economic classic*. (K. McCreadie, Ed.). Oxford: Infinite Ideas. Retrieved from http://www.books24x7.com/marc.asp?bookid=32901

Solomon, B. D., Barnes, J. R., & Halvorsen, K. E. (2007). Grain and cellulosic ethanol: History, economics, and energy policy. *JBB Biomass and Bioenergy*, *31*(6), 416–425.

Somers, M. R. (1993). Citizenship and the Place of the Public Sphere: Law, Community, and Political Culture in the Transition to Democracy. *Amersocirevi American Sociological Review*, *58*(5), 587–620.

Somers, M. R., & Block, F. (2005). From Poverty to Perversity: Ideas, Markets, and Institutions over 200 Years of Welfare Debate. *American Sociological Review*, *70*(2), 260–287.

Sperling, Daniel. (n.d.). Public-Private Technology R&D Partnerships: Lesson from U.S. Partnership for a New Generation of Vehicles. *Technology Policy*, *8*, 247–256.

Sticklen M. (2006). Plant genetic engineering to improve biomass characteristics for biofuels. *Current Opinion in Biotechnology*, *17*(3), 315–9.

Stine, D. D. (2009). Advanced Research Projects Agency-Energy (ARPA-E): Background, Status, and Selected Issues for Congress. Retrieved from http://digitalcommons.unl.edu/crsdocs/55/

Stone, R. (2007). Can Palm Oil Plantations Come Clean? *Science*, *317*(5844), 1491–1491. https://doi.org/10.1126/science.317.5844.1491

Stone, R. (2007). Can Palm Oil Plantations Come Clean? *Science*, *317*(5844), 1491–1491. https://doi.org/10.1126/science.317.5844.1491

Suzigan, W. (1991). Situação Atual da Indústria Brasileira e Implicações para a Política Industrial. *Planejamento e Políticas Públicas*, *6*, 121–143.

Swidler, A. (1986). Culture in Action: Symbols and Strategies. *Amersocirevi American Sociological Review*, *51*(2), 273–286.

Swilling, M., & Annecke, E. (2012). *Just transitions : explorations of sustainability in an unfair world.* Claremont, South Africa : UCT Press ; Tokyo, Japan : published in North America, Europe and Asia by United Nations University Press, 2012. Retrieved from http://search.ebscohost.com/login.aspx?direct=true&db=cat04202a&AN=ucb.b20783362&site=eds-live

Synnott, B. T. (2005). Some notes on the early years of FSC.

Sze, J., Gambirazzio, G., Karner, A., Rowan, D., London, J., & Niemeier, D. (2009). Best in show? Climate and environmental justice policy in California. *Environmental Justice*, *2*(4), 179–184.

Tarrow, S. G. (1998). *Power in movement : social movements and contentious politics*. Cambridge [England]; New York: Cambridge University Press.

Taylor, F. W. (2004). The Principles of Scientific Management. Retrieved from http://www.gutenberg.org/etext/6435

Tenenbaum, DJ. (2008). Food vs. Fuel: Diversion of Crops Could Cause More Hunger. *Environ Health Perspect*, *116*(6), A254-7.

The Economist. (2010, August 5). Picking winners, saving losers. *The Economist*. Retrieved from http://www.economist.com/node/16741043

Thelen, K. (1999). Historical Institutionalism in Comparative Politics. *Annual Review of Political Science*, *2*(1), 369–404. https://doi.org/10.1146/annurev.polisci.2.1.369

Thompson, S., Garcia, P., & Wildman, L. D. (1996). The Demise of the High Fructose Corn Syrup Futures Contract. *JOURNAL OF FUTURES MARKETS*, *16*(6), 697–624.

Tilly, C. (1993). National self-determination as a problem for all of us. (Daedalus Issue: Reconstructing Nations and States; includes bibliography). *Daedalus*, *122*(3).

Tilman D, Socolow R, Foley JA, Hill J, Larson E, Lynd L, … Williams R. (2009). Energy. Beneficial biofuels--the food, energy, and environment trilemma. *Science (New York, N.Y.)*, *325*(5938), 270–1.

Tollefson C., Gale F, & Haley D. (2008). *Setting the standard: certification, governance and the forest stewardship council*. University of British Columbia, Vancouver.

Tubiello, F. N., Salvatore, M., Cóndor Golec, R. D., Ferrara, A., Rossi, S., Biancalani, R., … Flammini, A. (2014). Agriculture, forestry and other land use emissions by sources and removals by sinks. *Rome, Italy*. Retrieved from http://www.uncclearn.org/sites/default/files/inventory/fao198.pdf

Tullo Vigevani, & Marcelo Fernandes de Oliveira. (2007). Brazilian Foreign Policy in the Cardoso Era : The Search for Autonomy through Integration. *Latin American Perspectives*, *34*(5), 58–80.

Turgeon, L. (1996). *Bastard Keynesianism : the evolution of economic thinking and policymaking since World War II*. Westport, Conn.: Greenwood Press.

Tyner, W. E., Dooley, F. J., & Viteri, D. (2011). Alternative Pathways for Fulfilling the RFS Mandate. *Amerjagriecon American Journal of Agricultural Economics*, *93*(2), 465–472.

UK Renewable Fuels Agency. (2008). The Gallagher Review of the indirect effects of biofuels production. Retrieved August 15, 2017, from https://www.unido.org/fileadmin/user_media/UNIDO_Header_Site/Subsites/Green_Industry_Asia_Conference__Maanila_/GC13/Gallagher_Report.pdf

U.S. Congress, Senate Committee on Energy and Natural Resources. (n.d.). *EPA's proposed renewable oxygenate standard : hearing before the Committee on Energy and Natural Resources, United States Senate, One Hundred Third Congress, second session ... May 12, 1994*. U.S. G.P.O., Supt. of Docs., Congressional Sales Office. Retrieved from https://lccn.loc.gov/95101427

U.S. Department of Energy, Energy Information Administration. (2014). International Energy Statistics, Total Biofuels Production 2014. Retrieved August 10, 2017, from https://www.eia.gov/beta/international/data/browser/#/?pa=000002&c=ruvvvvvfvtvnvv1urvvvvfvvvvvvfvvvou20evvvvvvvvvvnvvuvo&ct=0&tl_id=79-A&vs=INTL.79-1-AFG-TBPD.A&vo=0&v=H&start=2000&end=2014

U.S. Energy Information Administration (EIA). (n.d.). U.S. fuel ethanol production continues to grow in 2017 - Today in Energy -. Retrieved August 11, 2017, from https://www.eia.gov/todayinenergy/detail.php?id=32152

van Dam, J., Junginger, M., Faaij, A., Jrgens, I., Best, G., & Fritsche, U. (2008). Overview of recent developments in sustainable biomass certification. *JBB Biomass and Bioenergy*, *32*(8), 749–780.

Viana, V. (1996). *Certification of forest products : issues and perspectives*. Washington, D.C.; Covelo, California: Island Press.

Wade, Robert. (2003). *Governing the Market: Economic Theory and the Role of Government in East Asian Industrialization*. Princeton, NJ: Princeton University Press.

Wald, Matthew L. (1992, August 3). It Burns More Cleanly, but Ethanol Still Raises Air-Quality Concerns. *New York Times*. Retrieved from http://www.nytimes.com/1992/08/03/business/it-burns-more-cleanly-but-ethanol-still-raises-air-quality-concerns.html?pagewanted=all&src=pm

Wald, Matthew L. (2013, January 26). Court Overturns E.P.A.'s Biofuels Mandate - The New York Times. Retrieved August 11, 2017, from http://www.nytimes.com/2013/01/26/business/energy-environment/court-overturns-epas-biofuels-mandate.html

Wall Street Journal. (2013, March 28). The Experts: Should the Government Finance New-Energy Technologies? *Wall Street Journal*. Retrieved from https://www.wsj.com/articles/SB10001424127887324685104578386444147141104

Wallerstein, I. M. (2005). After developmentalism and globalization, what? *Social Forces*, *83*(3), 1263–1278.

Wang M, Wu, M, Huo, H, & Liu, J. (2008). Life-cycle energy use and greenhouse gas emission implications of Brazilian sugarcane ethanol production simulated with the GREET model. *International Sugar Journal*, *110*, 527–45.

Wang, Michael, May Wu, & Hong Huo. (2007). Life-cycle energy and greenhouse gas emission impacts of different corn ethanol plant types. *Environmental Research Letters*, *2*(2).

Wapner, P. K. (1996). *Environmental activism and world civic politics*. Albany: State University of New York Press.

Watts, M. (2012). A Tale of Two Gulfs: Life, Death, and Dispossession along Two Oil Frontiers. *American Quarterly*, *64*(3), 437–467. https://doi.org/10.1353/aq.2012.0039

Weinstein, M. M., & Charnovitz, S. (2001). The Greening of the WTO. *Foreign Affairs Foreign Affairs*, *80*(6), 147–156.

Weir, M. (1992). *Politics and jobs : the boundaries of employment policy in the United States*. Princeton, N.J.: Princeton University Press.

Weyland, K. (1998). From Leviathan to Gulliver? The Decline of the Developmental State in Brazil. *Governance*, *11*(1), 51.

White House. (2012). *National Bioeconomy Blueprint*.

White JS. (2008). Straight talk about high-fructose corn syrup: what it is and what it ain't. *The American Journal of Clinical Nutrition*, *88*(6).

Wiarda, H. J. (1997). *Corporatism and comparative politics : the other great "ism."* Armonk, NY: M.E. Sharpe.

Wilkinson, J., & Herrera, S. (2010). Biofuels in Brazil: debates and impacts. *The Journal of Peasant Studies*, *37*(4), 749–768.

Wilkinson, J, & Sorj, B. (1992). *Structural Adjustment and the Institutional Dimensions of Agricultural Research and Development in Brazil: Soybeans, Wheat, and Sugar Cane* (OECD/GD No. 92). Paris: OECD Development Centre.

Williams, P. R. D., Inman, D., Aden, A., & Heath, G. A. (2009). Environmental and Sustainability Factors Associated With Next-Generation Biofuels in the U.S.: What Do We Really Know? *Environmental Science & Technology*, *43*(13), 4763–4775. https://doi.org/10.1021/es900250d

Wolford, W. (2008). Environmental Justice and the Construction of Scale in Brazilian Agriculture. *Society & Natural Resources*, *21*(7).

World Bank. (1994). *Brazil: An Agenda for Stabilization* (No. 13168–BR). Country Operations Division, Country Department I, Latin America and Caribbean Region. Retrieved from http://documents.worldbank.org/curated/en/633981468743793621/pdf/multi0page.pdf

World Trade Organization. Agreement on Subsidies and Countervailing Measures, Marrakesh Agreement Establishing the World Trade Organization, § Annex 1A, 869 U.N.T.S. 14. (1994). Retrieved from http://www.ictsd.net/downloads/2012/02/biofuels-subsidies-and-the-law-of-the-wto.pdf

World Trade Organization. DISPUTE SETTLEMENT: DISPUTE DS456, India — Certain Measures Relating to Solar Cells and Solar Modules (October 16, 2016). Retrieved from https://www.wto.org/english/tratop_e/dispu_e/cases_e/ds456_e.htm

Wright, Gavin. (1990). The Origins of American Industrial Success, 1879-1940. *American Economic Review*, *80*(4), 651–68.

WWF. (2015). WWF Highlight: Sugarcane. Retrieved from www.panda.org/markets

WWF (World Wildlife Foundation) Germany. (2006). *Sustainability Standards for Bioenergy*. Retrieved from WWF_Sustainable_Bioenergy_final_version.pdf

Wyman CE. (2007). What is (and is not) vital to advancing cellulosic ethanol. *Trends in Biotechnology*, *25*(4), 153–7.

Yacobucci, Brent D. (n.d.). *Biofuels Incentives: A Summary of Federal Programs* (Congressional Research Service 7-5700 No. R40110). Retrieved from https://fas.org/sgp/crs/misc/R40110.pdf

Young, Oran. (1997). *Global governance : drawing insights from the environmental experience*. Cambridge, Mass.: MIT Press.

Zabin, Carol, Martin, Abigail, Morello-Frosch, Rachel, Pastor, Manuel, & Sadd, Jim. (2016). *Advancing-Equity.pdf* (p. 114). Center for Labor Research and Education, Don Vial Center on Employment in the Green Economy. Retrieved from http://laborcenter.berkeley.edu/pdf/2016/Advancing-Equity.pdf

Zeitlin, J. (2015). Extending experimentalist governance? : the European Union and transnational regulation.

Zeitlin, J. (2016). EU Experimentalist Governance in Times of Crisis. *West European Politics*, *39*(5), 1073–1094.

Zuurbier, P. J. P., & Vooren, J. van de. (2008). *Sugarcane ethanol : contributions to climate change mitigation and the environment*. Wageningen, the Netherlands: Wageningen Academic Publishers.