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Harland Prechel

Department of Sociology, Texas A&M University, College Station, Texas, USA

ABSTRACT
An organizational political economy perspective is elaborated to explain greenhouse gas emissions in the high polluting U.S. electrical energy industry. The analysis includes an examination of neoliberal organizational and political-legal arrangements and how the managerial class in parent companies make substantively different strategic investment decisions that affect greenhouse gas emissions. The quantitative analysis examines the effects of corporate characteristics and political embeddedness greenhouse gas emissions in the high-polluting energy sector. Findings show that parent company size, organizational complexity, political embeddedness, and the interaction of size and political embeddedness in the largest electrical energy producing corporations effect their greenhouse gas emissions.

KEYWORDS
Corporate GHG Emissions; organizational and political-legal characterisitcs

Researchers from multiple disciplines document that greenhouse gas (GHG) emissions present an unequivocal threat to nature and society (AAAS Climate Science Panel 2014; Intergovernment Panel on Climate Change 2013, 2019; United Nations 2019) and most climate scientists agree that humanly produced GHG is the primary cause of climate change as heat-trapping emissions continue to rise (Brown et al. 2016; World Meteorological Organization 2014). Although climate change has only recently become a public issue, President Johnson issued a report in 1965 warning about the relationship between GHG emissions and climate change. In response, the fossil fuel trade association advocated for an industry wide lobby effort to limit regulation and corporations launched a campaign to challenge the legitimacy of climate change science. Although the scientific evidence confirming that much climate change is humanly created and the dispersion of the evidence is bringing about a shift in public consciousness regarding climate change from a future threat to a present danger, many corporations in the fossil fuel regime continue to resist changing their strategy and structure in ways that reduces their GHG emissions. Instead of making the necessary capital investments to reduce their GHG emissions, many corporations continued to question the scientific evidence and the magnitude of the risks (Banerjee, Song, and Hasemyer 2015; Dunlap and Brulle 2015; McCright and Dunlap 2003; Mitchel 2013; Stern et al. 2016:653).

Despite the danger to nature and society, sociology has been slow to engage in climate change research (Brulle and Dunlap 2015; Dunlap 2010; York and Dunlap 2012). The primary

CONTACT Harland Prechel hprechel@tamu.edu TAMU 4351 Department of Sociology, College Station, TX 77843-4351, USA.

exception is research focusing on macro-level dimensions of the social structure. Macro-level researchers document how climate change and other forms of environmental pollution are linked to economic growth and development (Catton 1980; Downey 2015; Dunlap and Catton 1979; Foster, Clark, and York 2010; Gould, Pellow, and Schnaiberg 2008; O'Connor 1998) and how elite controlled organizational, institutional (e.g., World Bank), and network-based inequality affect macro-structures that cause environmental harm (Downey 2015:11). Others focus on micro-level issues. Drawing from George Herbert Mead and Erving Goffman, micro-level theories of the environment provide insights into how the environment frames everyday life (Bell and Ashwood 2015; Brewster and Puddephatt 2015).[1]

Meso-organizational level analysis of human impacts on the environment and climate are also receiving more attention. After Perrow (1997:66) asserted that organizations are the "most intensive and effective environmental destroyers," researchers began to examine the relationship between toxic emissions and plant size (Grant and Jones 2003; Grant, Jones and Bergesen 2002), combinations of community and plant characteristics (Grant et al. 2010), and how nongovernmental organizations directly and indirectly affect emissions (Grant and Vasi 2017; McCright and Dunlap 2008).

Recent research on global power plant CO2 emissions employ data compiled by Carbon Monitoring for Action (CARMA). Given that many countries do not report CO2 emissions, CARMA uses statistical models to estimate CO2 emissions for many of the power plants in their database.[2] Employing qualitative comparative analysis (QCA), Grant and his colleagues conclude that different combinations of global, political, and plant characteristics including age, size and location of power plants in the global economy interact with efficiency to affect CO2 emissions (Grant, Jorgenson, and Longhofer 2016). These researchers suggest that the largest polluters in the global economy pursue four distinct pathways to pollution that entail different configurations of characteristics including variations in national political institutions, environmental movement organizations, and governance units (Grant, Jorgenson, and Longhofer 2018). Although plant-focused analyses are useful to understand the human causes and consequences of environmental pollution, they do not explain the relationship between corporations and environmental pollution.

Thus, questions remain about the effects of corporate characteristics on environmental pollution. To better understand this relationship, climate change scientists call for greater emphasis in the social and behavioral sciences to incorporate technological and institutional options into a science of human-environment interaction (Stern et al. 2016). In a similar vein, environmental sociologists call for constructing theory and research that has implications for sustainability and public policy (Dunlap and Brulle 2015; Dunlap and Catton 1979; Freudenburg et al. 2009). However, with few exceptions (Perrow and Pulver 2015; Prechel 2012; Prechel and Istvan 2016; Prechel and Zheng 2012; Pulver 2011; Shwom 2009), corporate characteristics and corporate political behavior remain a black box with regard to environmental pollution, especially GHG emissions.

It is important to fill this lacuna in the literature because corporations, especially the largest corporations, are responsible for a large portion of GHG emissions. This article addresses this gap in the climate change literature by focusing on the meso-corporate level of analysis and positing the following question: How do the organizational and political-legal arrangements of ultimate parent companies affect greenhouse gas (GHG) emissions in the electrical power plants they control?

This paper summarizing how neoliberal policies affect the electrical energy sector, provides illustrations of how variation in ultimate parent companies strategic decisions affects GHG emissions in their facilities, and presents a quantitative analysis examining the effects of organizational and political-legal arrangements on GHG emissions in the largest US electrical energy producing corporations.

Why Focus on Ultimate Parent Companies?

The relationship between capitalism and environment was articulated by the classical social theorists including Marx (1865 [1981]:915–16) who described how capitalist production extracts natural resources without replenishing them creating a metabolic rift and Weber's conception of how formally rational capitalism accelerates the rate of fossil fuel burning (Weber 1958:181). Although the corporation is the loci where much fossil fuel production and consumption occurs, the meso-level corporation receives little attention by environmental sociologists. Even neo-Marxists who made many important contributions to understanding the relationship between capitalism and ecology give little attention to the meso-level where GHG emissions are produced. To illustrate, the treadmill of production (Schnaiberg 1980), metabolic rift (Foster, Clark, and York 2010), and world-ecology (Moore 2011) all focus on macro-level processes and give little attention to the point of production.

Organizational political economy suggests that it is important to examine the meso corporate level and the relations between corporations and the state. Corporate-state relations underwent substantial changes in response to the capital accumulation crisis of the 1970s and early 1980s. By the mid-1980s and early 1990s, neoliberal political-legal arrangements permitted US corporations to adopt the multilayer-subsidiary form where the ultimate parent company (hereafter UPC) holds ownership control over an increasingly large and complex network of legally independent subsidiary corporations where most power plants are located (Prechel 2012). Within this multilayer-subsidiary form, strategic decisions are made in UPCs, which operate as financial management companies (Prechel 2000:217–220), including the allocation of resources to install pollution abatement technologies in its power plants or shifting to renewable energy (see Figure 1).

Restructuring as the multilayer-subsidiary form is a crucial component of the financialization of the corporation. UPCs are at the apex of this organizational hierarchy and, like the early 20th century holding company, establish ownership control over plants directly or indirectly through subsidiary corporations (Prechel 2000:207). *Strategic investment decisions* related to environmental pollution include acquiring or constructing plants that use high polluting fuels, converting (or not) plants to use less polluting fuels, investing (or not) in pollution abatement technologies such as scrubbers in coal-fired plants, and constructing or acquiring renewable energy sources. Thus, much of the polluting behavior of plants is an outcome of the collective history of strategic investment decisions made in the UPC.

One of the primary characteristics that differentiate contemporary society from the middle decades of the 20th century is the emergence of the *managerial class*: top managers who own a substantial share of corporate securities making them both top managers and owners (Prechel 2019; Prechel Forthcoming). This change in the class structure is the outcome of pressures to increase shareholder value and the use of stocks and stock options

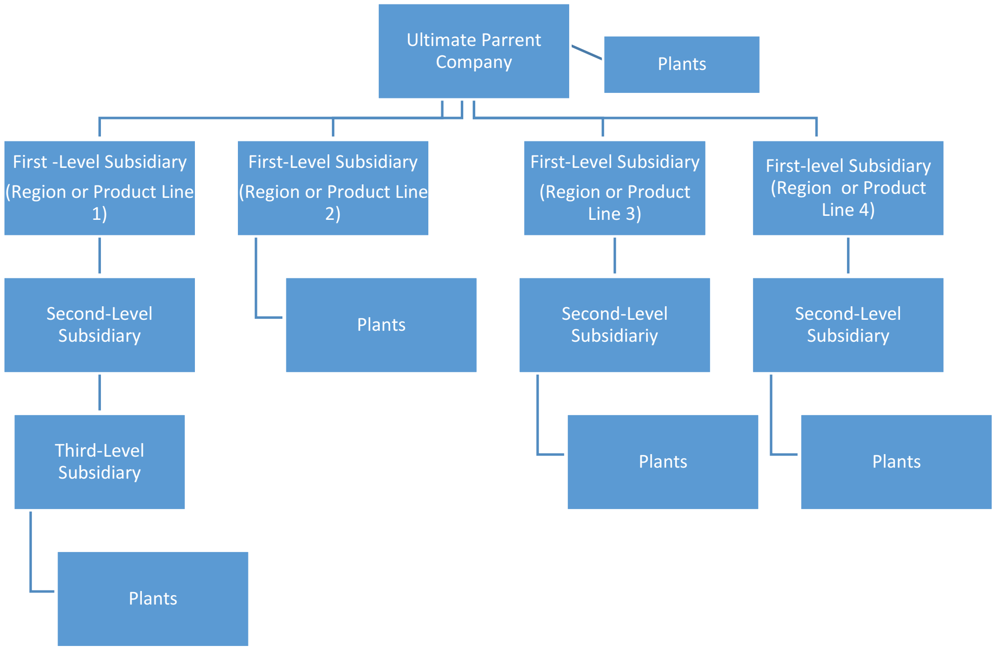

Figure 1. Organizational prototype of the multilayer-subsidiary form*.

* From Prechel and Istvan (2016). This figure represents a scaled down version of the multilayer-subsidiary form as most corporations in the study group are much larger and more complex.

as incentives to encourage managers to behavior more like owners. While stock options were used for decades, the expanded use of stock options as executive compensation in recent years resulted in a rapid increase in stock ownership by top managers who overtime have become major stockholders in the corporation. Change to the multilayer-subsidiary form and subsequent corporate consolidation further increased the power of the managerial class by placing more organizational resources under their control. A crucial dimension of the increased power of the managerial class is neoliberal political-legal arrangements (e.g., relaxed antitrust enforcement) permit the emergence of larger corporations. Thus, the strategic decisions of the top echelon of the managerial class have a larger effect on the use of organizational resources under their control.

It is widely known that neoliberal re-regulation in the 1980s and 1990s had multiple effects on corporate America, especially financial corporations. However, less is known about the effects of neoliberal re-regulation on other economic sectors including the electrical energy industry. In additional to permitting corporations to restructure as the multilayer-subsidiary form and pursue consolidation strategies, non-utility companies were permitted merge with or acquire electrical power plants and in some cases entire utility companies. To illustrate, prior to filing for bankruptcy, Enron Corp. acquired the utility Portland Electric. In 2016, directly or indirectly through its subsidiaries, the conglomerate Berkshire Hathaway held ownership control (i.e., more than 50%) over more than 25 power plants. By the early 21st century, several utility and non-utility corporations held ownership control over multiple subsidiaries and power plants increasing their organizational size and complexity. Several UPCs in this study hold ownership control over more than 30 plants including some of the largest coal-fired power plants in the US. Given that UPCs hold ownership control over multiple plants, it is important to understand how decisions made in the UPC affect GHG emissions.

Another reason for selecting the UPC as the unit of analysis is subsidiaries and the plants organized under them are not independent observations. Thus, these organizational entities should not be treated as if they were independent observations when conducting statistical analysis.

Despite the crucial importance of UPCs strategic decisions on GHG emissions, little information is available to assist political leaders, concerned citizens, social movement organizations, and progressive corporate management on how UPCs might better manage their GHG emissions. This information deficit contributes to the "near-hegemonic belief systems that market-based policies are the only feasible options for reducing carbon emissions" (Brulle and Dunlap 2015:17; Stavins 2000; Buttel 2004).

To fill this gap in the literature, several qualitative studies focus on how corporations exercise power to influence the risk of climate change from GHG emissions (Perrow 2010; Perrow and Pulver 2015; Prechel 2012; Pulver 2011; Shwom 2009). A few quantitative studies examine the relationship between corporate characteristics and GHGs, but they are limited to a small number of organizational characteristics such as size (Austin and Sauer 2002; Douglas 2006). Thus, several fundamental questions remain unanswered about the relationship between corporations and GHG emissions.

While some scholars suggest that more attention be given to "upstream" dimension of the social structure (Brule and Dunlap 2015; Dunlap 2010), I argue that more attention should also be given to the "midstream" dimensions of the social structure. Specifically, plants, where environmental pollution occurs, is at the bottom of the social structure with national governments and global institutions (e.g., World Bank) at the top. By examining the midstream dimension of the social structure, this paper contributes to how the collective history of strategic decisions in UPCs, where top management is located, affect GHG emissions in the power plants under their control. I focus on the largest corporation as, in this era of giant investor-owned UPCs, more than half of the global GHGs are produced by just 25 corporate and state organizations and just 224 companies produce 75% of annual global GHG emissions (Griffin 2017). Thus, it is imperative that research focus on the effects of the largest corporations on GHG emissions.

Variation in UPCs Strategic Investment Decisions and Their Effects on Power Plants' GHGs

The following illustrates how two UPCs made very different strategic decisions that affect GHG emission in their power plants. These UPCs, Alliant Energy and Energy Future Holdings, were selected because they are similar in crucial ways: (1) they are public utility corporations, (2) have ownership control of power plants through their subsidiary corporations, and (3) the Environmental Protection Agency (EPA) cited their largest coal-fired power plants multiple times for violating the Clean Air Act.

Alliant Energy, through its subsidiary Wisconsin Power and Light, owns Columbia Energy Center, which consists of two coal-fired power plants that are its largest and highest polluting plants. In 2012, top management in this UPC made the strategic decision to allocate 900 USD million to modernize these plants by investing in scrubbers and other pollution abatement technologies.

Like Alliant Energy, other UPCs make strategic decisions to limit their polluting behavior. To illustrate, historically, NRG Energy and its subsidiaries relied almost exclusively on fossil fuels to generate energy. However, in 2016, top management in NGR's UPC made the strategic decision to acquire the solar and wind assets of the bankrupt SunEdison, which was the fastest growing renewable energy firm in the US (Blum 2016), and organized it as a legally independent subsidiary corporation.

Top managers in other UPC make sharply different strategic investment decisions. To illustrate, Energy Future Holdings, through its subsidiary Luminant Generation Co., owns the Martin Lake plant that is the highest polluting power plant in Texas emitting almost 19 million metric tons of heat trapping GHGs annually (Tresaugue et al. 2012). Although this facility was the target of local environmental organizations, Energy Future did not invest in pollution abatement technologies in this power plant, in part, because of previous strategic decisions. After re-regulation of the energy and finance sectors, Energy Future diversified into finance and natural gas. However, the sharp decline in financial markets that followed the 2008 financial crisis and the decline of natural gas prices caused by increased supply left the UPC with high debt, high costs, and low profits, which constrains cash flow and limited its capacity to invest in pollution abatement technologies. Unable to resolve its financial problems, Energy Futures Holdings filed for bankruptcy protection in 2014. Shortly after it reemerged from bankruptcy in 2016, the UPC was renamed Vistra Energy and began trading as a public corporation with several power plants organized under its first-level subsidiary, Luminant Generation Corp. In 2018, Vistra Energy merged with another giant energy company, Dynegy.

These illustrations provide several insights into the relationships between UPCs and GHG emissions. First, UPCs are the organizational loci where top management makes large-scale investments decisions that affect GHG emissions. Second, some UPCs make strategic decisions to lower pollution and others do not, which results in substantial variation in their GHG emissions. Third, identifying the worst polluting plants and citing them for their polluting behavior is no guarantee that UPCs will allocate the capital necessary to reduce the polluting behavior in their plants. Fourth, GHG emissions from plants are effected by the collective history of strategic decisions in the UPC. While it is widely accepted that a few industries are responsible for a large portion of environmental pollution (Collins, Munoz and JaJa 2016; Environmental Protect Agency 2014; Freudenburg 2005), these examples show that UPCs within the same industry pollute at disproportional different rates. The challenge is to better understand how UPC characteristics explain difference in the environmental pollution in the organizational entities under their control.

This study is timely for many reasons. The most important reason is the production of heat-trapping GHG emissions is rapidly moving toward the tipping point and little progress is being made toward reducing GHG emissions (United Nations 2019). The annual growth rate of atmospheric CO2 was 3.03 and 3.00 part per million respectively in 2015 and 2016, which are the largest annual increases in 59 years (Kahn 2017). Further, the recent catastrophic storms that resulted in widespread flooding and wind damage in Houston and other parts of southeast Texas, Louisiana, Florida, and Puerto Rico are likely affected by higher than normal water temperature in the Gulf of Mexico, which fuel tropical storms and hurricanes. Therefore, information on UPCs polluting behavior are necessary to enact effective policy remedies.

Conceptual Framework: Organizational Political Economy

Organizational political economy links three theoretical presuppositions to explain corporation polluting behavior. First, markets, states, corporations and ideologies are all intertwined and cannot be understood in isolation from one another. The false belief in a self-regulating market was exposed by Polanyi (1944[2001]) decades ago when he demonstrated that there is no such thing as a free market as markets are embedded in political-legal and cultural arrangements. Corporate-state relations in contemporary capitalism have a complex "configuration of economic and political" arrangements and a dominant set of ideas to legitimate them (Kotz 2015:3) that set the outside parameters of acceptable behavior. Because capitalism is prone to periodic crisis, resolution requires realignment of economic, ideological and political institutional arrangements (Gordon, Edwards, and Reich 1982). Thus, "political embeddedness is not a static concept and embeddedness and disembeddedness are best conceptualized as ideal types that are located on two ends of a single continuum" (Prechel 2000) that are affected by changes in national and subnational state policies as well as international agreements among nation-states. For these reasons, the term deregulation is rejected as it implies that rules are eliminated. Instead, re-regulation is used to capture the process of replacing previous rules with new rules in which markets are embedded.

Second, organizations are open systems that are dependent on resources controlled by other organizations in their environment (Pfeffer and Salancik 1978). For example, electrical energy producing UPCs are dependent on resources held by organizations that provide capital, produce fuel, and construct transmission lines to move electricity through the grid. UPCs are also dependent on governments to provide the legal framework that define corporate property rights and market parameters. When corporations become more capital dependent, they mobilize politically to pressure governments to redefine their political embeddedness in ways that facilitate their capital accumulation agendas.

Third, organizations are used to advance the agendas of those who control them (Perrow 1986: 11). However, not all members of society control organizations. Organizations are largely the tools of elites; "the power of the rich lies not in their ability to buy goods and services, but in their capacity to control the ends toward which the vast resources of large organizations are directed" (Perrow 1986:12). *Organizational power* is the capacity to advance their agendas even when other social actors resist (Weber 1921 [1978]).

The framework here specifies Weber's conception of power in more detail by drawing on Levy and Egan (1998) distinction between structural power and instrumental power. Whereas *structural power* is a component of the social structure and includes the resources held in organizations, *instrumental power* is the ability to use the capital invested in the corporation. Businesses elites use the capital invested in corporations to engage in political capitalism to influence government policies Kolko (1963). In contemporary society, there are three interrelated dimensions of *political capitalism*: the exercise of power (1) outside the state where business interests attempt to control the political debate, (2) in the legislative process where broad policy parameters are established, and (3) in state agencies that have authority over policy implementation and enforcement (Prechel 2000:277). Whereas resources invested in public corporations increase the resources controlled by top management in the UPC thereby increasing their structural power, management with control over more resources have greater instrumental power to advance their capital accumulation interests politically (Prechel 2015:831).

Given that components of the social structure are interdependent, some characteristics of the social structure may only appear because of the way in which its components are assembled (York and Clark 2007: 720). It is particularly important to examine UPCs at this point in time because neoliberal re-regulation permitted the emergence and spread of the multilayer-subsidiary form that facilitated the centralization and concentration of capital within a few giant corporations to levels similar to the 1920s and 1930s when these corporations used their power to exercise control over markets.

In summary, organizational political economy conceptualizes corporations as social actors embedded in economic, ideological, and political-legal arrangements that mobilize politically to redefine their political embeddedness in ways that facilitate their capital accumulation agendas. The contemporary reconfiguration of the social structure represents a shift from fated risks in traditional societies to created risks in modern society wherein the primary focus of technical knowledge is to facilitate economic growth and development (Beck 2009:25; Brulle 2000). The focus here is on how the reconfiguration of corporate characteristics and political-legal arrangements affect risk to society in the form of GHG emissions.

This focus joins a growing number of sociologists who place renewed emphasis on organizational structures and hierarchies, which was displaced in recent years by a focus on organizational culture and institutional norms (Gray and Silbey 2014; Walker and Rea 2014). Organizational political economy also complements research in environmental sociology that emphasizes social structure. To illustrate, whereas Grant and his colleagues focus on how configurations of global, community and plant characteristics affect environmental pollution (Grant, Jorgenson, and Longhofer 2018; Grant and Vasi 2017), Downey (2015) focuses on how macro-level processes and structures effects environmental inequality. Organizational political economy complements these perspectives by focusing on UPCs that engage in political capitalism to control their resource dependence and make strategic decisions affecting GHG emissions in the power plants they control.

Historical Contextualization: Redefining Political-Legal Arrangements

In response to the economic downturns in the 1970s, corporations became more politically active and exercised instrumental power to redefine their political embeddedness in ways that increased their structural power by pressuring elected and appointed state managers to advance their capital accumulation agendas. The subsequent realignment of corporate-state relations increased corporations' structural power – resources under UPCs control – by dismantling crucial environmental controls, shifting partial enforcement authority of environmental regulations from the state to subnational states, and permitting consolidation of energy production into fewer corporations (Prechel 2012). Corporations also used their instrumental power by investing resources to conceal their polluting activities (Beamish 2002; Kolk and Pinkse 2005; Pulver 2011) and control the public debate on environmental pollution (Crane, Matten, and Moon 2008; Hamilton 1995; Stern et al. 2016).

Among the most important change in corporate-state relations in the late 20th century is legislation to expanded corporate property rights. Corporations exercised their instrumental power to convince the Reagan Administration and Congress to add a little known provision to the Tax Reform Act of 1986, eliminating the 1930s New Deal tax on capital transfers from subsidiaries to parent companies. This political-legal change made it viable for corporations to restructure as the multilayer-subsidiary form where the legally independent UPC replaced the central office of the multidivisional form where all corporate entities were part of the same legal entity (Prechel 2000).

The multilayer-subsidiary form is a key component of the transition to financialization as it permits top management to establish ownership control by owning a simple majority of subsidiaries' stock thereby permitting UPCs to raise capital by selling up to 50% of the stock in their wholly-owned subsidiaries to finance current and future acquisitions (Prechel 2000:263). Thus, the multilayer-subsidiary form provides a mechanism to organize multiple previously independent corporations under a single UPC where top management holds authority to set decision-making criteria in them while providing a mechanism to acquire other companies and incorporate them as subsidiaries. This structure also provides UPCs with the capacity to shift risk to their subsidiaries by leveraging their assets to obtain loans to finance large-scale pollution reduction projects, acquire production plants fueled by renewable energy sources, convert production plants to less polluting fuels, and diversify into alternative product lines. At the same time, the organizational and financial flexible of the multilayer-subsidiary form limits transparency and public accountability as there is no requirement that plant and subsidiary names reflect the UPC's name. Most important, decisions in these large and complex corporations are made deep inside the corporation concealed from government regulators and the public scrutiny (Prechel Forthcoming).

The reconfiguration of corporate-state relations also made it possible for UPCs to avoid EPA regulations. Specifically, neoliberal re-regulation shifted authority over enforcement of EPA regulations to subnational states where facilities are located. These political-legal arrangements create opportunities for UPCs to use the multilayer-subsidiary form to concentrate their production facilities in states with weak environmental policies and use the grid to transmit energy to markets in other states.

The following sections of the paper develop hypotheses from the organizational political economy framework and present the quantitative analysis of UPCs organizational and political-legal arrangements on GHG emissions.

Hypotheses

The first hypothesis tests the effects organizational size on UPSs' GHG emissions. Hypotheses two through four test the effects of organizational complexity on UPCs' GHG emissions. Hypotheses five and six test the effects of UPCs political behavior and political embeddedness on GHG emissions. Hypothesis seven tests the effects of the interaction of UPC size and political embeddedness on GHG emissions.

Organizational Size

There is disagreement on the effects of organizational size on pollution. Some research shows that organizations with more assets are less likely to adopt pollution reduction technologies and more likely to resist regulatory control (Kerr, Lincoln, and Mishra 2014). Large corporations also use their massive resources to more actively question the scientific evidence supporting the human causes of climate change (e.g., Koch Industries). Further, financial penalties are not sufficiently high to deter large corporations from externalizing their environmental pollution (Prechel and Zheng 2012).

Other studies show that corporations with more assets are more likely to invest in technologies to lower pollution (Schneider, Hoffmann, and Gurjar 2009) as they have more incentives to contain their pollution. Incentives include exposure by environmental movement organizations, which tend to focus their protests on larger corporations (Ambec and Lanoie 2008). Larger corporations also have more access to capital markets (e.g., bank loans) to invest in pollution abatement technologies because bankers considered them more likely to survive than smaller corporations. In addition, large corporations generate investor confidence because they are more likely to disclose their emissions (Kolk and Pinkse 2007). Investor confidence is typically followed by higher stock valuations, which increases firms' value and access to external resources. This perspective is adopted resulting in the following hypothesize:

H1: Ultimate Parent Companies with more financial assets have lower GHG emissions.

Organizational Complexity

Organizational complexity can affect environmental pollution in several ways. First, goal conflict emerges in complex organizations, which create conditions where some goals have priority over others (Mohr 1973). Thus, even if UPCs establishes "green-oriented" goals, operating managers may reject environmental goals because of the real or perceived understanding that UPC management ties financial goals to salary increases and promotions. Second, bounded rationality undermines the capacity of top management to monitor subsidiary management in complex organizations (March and Simon 1958; Simon 1957). Third, organizational complexity creates opportunities to conceal managerial practices because complex organizations may entail decentralized authority and forms of accountability (Perrow 1997). The first two organizational complexity measurements are the number of subsidiaries and the number of plants under the ownership control of the parent company. These organizational complexity hypotheses state:

H2: Ultimate Parent Companies with more plants have higher GHG emissions.

H3: Ultimate Parent Companies with more subsidiaries have higher GHG emissions.

The third organizational complexity measure is the number of subsidiary layers organized under the UPC. There are three potential explanations for the relationship between multiple subsidiary layers and GHG emissions. More subsidiary layers can provide greater oversight and control over plant managers. Specifically, top management in UPCs may organize engineer-managers in a subsidiary between the UPC and production facilities to establish the premise of decisions and use computerized information processing systems to ensure that operating managers adhere to the formally rational decision-making criteria (Prechel 1994). These managerial and technical controls can offset bounded rationality associated with organizational complexity.

Also, each subsidiary layer creates a liability firewall that can provide legal protection for the UPC from risks and subsequent damages that occur in their production facilities. For example, in the event of a lawsuit stemming from damages caused by events at the point of production, in most cases plaintiffs must "pierce the corporate veil" (i.e., win the lawsuit) of each legally independent subsidiary layer before filing a lawsuit against the UPC where most assets are held.

Finally, multiple subsidiary layers limit transparency and, thus, public accountability as there is no requirement that subsidiary names reflect the UPC name. Thus, multiple layers of subsidiaries with different names limit the capacity of environmental movement organizations to identify and focus their protests on the UPC. In this way, subsidiary layers create obstacles to identifying the UPC responsible for their polluting behavior thereby limiting negative public exposure and pressure on UPC top management to invest in pollution abatement technologies. Thus, the following hypotheses states:

H4: Ultimate Parent Companies with more subsidiary layers have higher GHG emissions.

Corporate Political Behavior

A central presupposition in organizational resource dependence theory (Pfeffer and Salancik 1978) and some theories of the state Poulantzas ([1974] 1978) is organizations are dependent on resources controlled by other organizations in their environment. The resource of most concern to top management is capital as corporations' survival is dependent on it. To reduce their capital dependence, top management engages in political behavior to pressure the state to provide subsidies, tax credits and other tax policies to assist corporations in pursuing their capital accumulation agendas. The state can also reduce corporations' capital dependence by not enforcing pollution control policies or eliminating them as occurred during the Trump Administration. Political Action Committees (PACs) are one of the primary mechanisms (Boies 1989; Clawson and Neustadtl 1989; Mizruchi 1989) that corporations use to advance their economic agendas politically. PAC contributions provide corporations with access to politicians (Clawson, Neustadtl, and Scott 1992), which create opportunities to influence policies and policy enforcement. The following hypothesis measures the effects of corporate PAC on GHGs. This hypothesis states:

H5: Ultimate Parent Companies with higher PAC contributions have higher GHG emissions.

Subnational State Environmental Policies

Although federal environmental regulations standardize pollution controls, neoliberal policies shifted much of the authority over enforcement to subnational states where substantial variation exists in environmental policy and enforcement. Variation in states' environmental regulations are affected by the competing political agendas of economic development (Bluestone and Harrison 1982) and negotiations between federal agencies and subnational state and local political and economic interests (Shover, Clelland, and Lynxwiler 1986; Yeager and Simpson 2009). Organizational political economy suggests that UPCs adhere to the environmental laws and regulations where their headquarters are located because failure to do so can adversely affect access to resources controlled by subnational states such as tax credits and subsidies. Also, states with stronger environmental policies and laws legitimate environmental movement organizations, which may result in exposing of UPCs' polluting behavior that may result in lower stock price (Hamilton 1995; Koehler and Cram 2001) and a loss of market share (Ambec and Lanoie 2008; McCreery 2010). Following this logic, hypothesis six suggests that green policy scores of subnational states where UPCs are headquartered effect GHG emissions.

H6: Ultimate Parent Companies headquartered in subnational states with lower environmental standards have higher GHG emissions.

Interaction Effect of Subnational State Environmental Laws and UPC Size

Following the logic that the largest UPCs exercise political power to advance their economic agendas, this hypothesis suggests that UPCs with the most assets located in states with higher green rank have higher emissions. The exercise of power to advance their capital accumulation agendas may include threatening to move their corporate headquarters or plants to another state resulting in the loss of tax revenues and middle and upper income managerial and technical jobs. In addition, the managerial class in the largest UPCs use the substantial resources under their control to fund media campaigns stressing the neoliberal claim that government interference in the economy undermines efficiency. The following hypothesis maintains that the interaction of these variables will raise GHG emissions.

H7: Ultimate parent companies with higher assets that are located in states with higher green scores produce more GHG emissions.

Research Design

UPCs were selected as the unit of analysis because UPC top managers have decision-making authority over strategic decisions that affect plants GHG emissions. UPCs allocate capital and establish goals, priorities, and incentives in operating subsidiaries and plants.

The Study Group

The electrical energy production sector was selected for several reasons. First, this sector produces 30 percent of all U.S. GHG emissions (Environmental Protection Agency 2014), which is more GHG than all forms of transportation combined (i.e., 26 percent). Second, neoliberal re-regulation permitted consolidation of production facilities with fewer UPCs owning a larger share of production capability. To illustrate, whereas the largest 50 Fortune 500 industrial firms held less than 30 times as many assets as the smallest 50 firms between 1958 and 1977, following the implementation of neoliberal political-legal arrangements, this ratio increased to more than 60 times by 1993 (Prechel and Boies 1998:323). This strategy continues to the present as 75 percent of all US industries became more concentrated during the early 21st century (Grullon, Larkin, and Michaely 2019). This pattern of consolidation also occurred in the energy sector; between 1997 and 2001, the mean assets of energy companies in the Standard and Poor's 500 increased from 14.9 USD billion to 24.2 USD billion. Consolidation results in fewer UPCs holding ownership control over more power plants, which increases the effects of decisions made in UPCs. Directly or indirectly through their subsidiaries some UPCs in the study group hold ownership control over 30 or more plants and several UPCs hold ownership control over more than 20 plants. Further, as the above Alliant Energy and Energy Future Holdings comparison demonstrate, many of these plants are among the highest GHG emitters in the US.

Corporate consolidation and diversification strategies create challenges when conducting statistical analysis of UPCs. Consolidation reduces the number of UPCs in an economic sector and tends to create more diversified companies. In 2010, there were only 12 public UPCs that held ownership control over facilities in the EPA data set with a primary four-digit SIC code of 4911: companies engaged in the generation, transmission, or distribution of electricity. However, there are 30 additional companies with secondary SIC codes of 4911. Eliminating UPCs with a secondary SIC code of 4911 would exclude a substantial share of the largest electrical energy plants from the analysis. To illustrate, one UPC in the study group with a secondary SIC code of 4911 has ownership control over 30 plants. Three other UPCs hold ownership control over, 27, 25 and 23 plants, respectively. Excluding these four UPCs would eliminate 105 plants from the analysis. Therefore, the analysis includes UPCs with primary or secondary SIC codes of 4911.

A unique data set was compiled that includes the GHG emissions of plants in the EPA GHG data set that are controlled by UPCs in the Fortune 500. Then, the plant-level data were rolled up to the UPC to create the dependent variable of total GHG emissions of the entire corporation. The dataset contains 66 energy sector UPCs with the primary SIC codes described above. This longitudinal data set includes measures of the dependent variable in 2010 and 2011 and independent variables for 2009 and 2010. This research design permits a one-year lag thereby avoiding the simultaneity bias that may occur when the research design does not account for the time it requires management to respond to variables that may affect GHG emissions. There are 131 company-years in the regression analyses as one UPC was acquired during the study period. The first year of the data is 2010 as it is the first year the EPA made GHG data available.

The study group is limited to publicly traded UPCs for theoretical and methodological reasons. Specifically, corporate characteristics of publicly traded companies are different from other kinds of organizations and therefore are not comparable to them (e.g., private companies, municipalities). To illustrate, unlike private companies, publicly traded companies are responsive to stockholders. Also, the Securities and Exchange Commission has different report requirements for privately owned companies. As a result, data are not available on crucial independent variables for these organizations. Because the *Public Utility Holding Company Act of 1935* regulated this economic sector throughout the middle decades of the 20th century there are relatively few private firms in the electrical energy sector.

Dependent Variable

The dependent variable is GHG emissions, which we obtained from EPA's GHG Reporting Program. The dependent variable was standardized by assets. Although there is a correlation between CO2 and total GHG emissions with CO2 representing 82 percent of GHG emissions (Environmental Protection Agency 2014), GHG emissions is used as it is a more inclusive measure of heat-trapping emissions. In 2011, US electrical power plants emitted 2,208 million metric tons of CO2 and 9.2 and 4.2 million tons of nitrous oxide ($N^2 0$) and methane (CH^4), respectively (Environmental Protection Agency 2011). Given the ongoing shift from coal to natural gas in US electrical power plants, it is important to include all GHGs as natural gas combustion is a major source of methane.

Before proceeding an important clarification is in order. The EPA data does not conform to standard business data sources such as Lexis-Nexis Corporate Affiliations that refers to the corporate entity at the top of organizational hierarchy as the UPC and entities below it as *subsidiary corporations* in which the UPC establishes ownership control. In contrast, the EPA data designates corporate entities that hold ownership control (i.e., more than 50%) over a production facility as parent companies. As a result, the EPA does not link plants to their UPC. This way of compiling data can be misleading as it may lead researchers to incorrectly assume that EPA's parent corporation designation have decision-making control over production facilities organized under them when, in fact, these are subsidiary corporations over which the UPC holds ownership control. To correct for this problem, Lexis-Nexis data are used to identify the UPC and their subsidiary corporations.

The first step in compiling GHG emissions data identified energy sector UPCs in Lexis-Nexis Corporate Affiliations. Then, the plants in the EPAGHG data base with SIC codes described above were identified. After the plant emissions data were collected, they were rolled up to the UPC. In some cases, the plants are directly owned by the UPC. In most cases, the UPC owns plants through its subsidiary corporations. In these cases, we rolled plant emissions data up through the corporate hierarchy of subsidiaries until the compilation process reached the UPC. Although the EPA attempts to ensure accurate reporting of GHGs, it is possible that some underreporting occurs. However, methodologically, when data are underreported, there tends to be less variation and typically less statistically significant findings. Thus, if any GHGs are underreported, statistically significant findings from the analysis may be even stronger.

Independent and Control Variables

Data on the independent and control variables are from several databases in the Wharton Research Data System (WRDS) and elsewhere. Data on assets are from Compustat Financial (2009–2010). Assets is used to measure organizational size as it is a more direct measurement than other variables such as number of employees, which is affected by the level of technological innovation.

Three measures of organizational complexity are used. The number of domestic subsidiaries and subsidiary levels are from the LexisNexis Corporate Affiliations. Data on the third complexity measure is the number of production facilities owned by UPCs, which is collected from the EPA GHG emissions database.

Data on corporate PAC expenditures are from Open Secrets (www.opensecrets.org). Data on subnational state green scores are from Wingfield and Marcus (2007) who developed an index that measures environmental policies in subnational states. Using a scale of 0 to 50, with higher scores identifying more environmentally friendly states, the index includes six equally weighted categories: air quality, carbon footprint, hazardous waste management, water quality, and policy initiatives and energy consumption. The greenest states are Vermont, Oregon and Washington all with scores of 43 and a decimal and the least green states are West Virginia, Indiana and Alabama with green scores of 14.2, 15.3, 15.8, respectively, with Louisiana and Mississippi closely behind with green scores of 17 and 17.6, respectively. Thus, there is substantial variation in subnational state green scores.

Control variables include states that rely more on hydropower and age of the parent company. The measure of hydropower is a dummy variable for UPCs located in California, Oregon and Washington. Age of the UPC is included to control for age inertia because organizational theories maintain that sunk cost in existing plants, equipment, and personnel are impediments to change and corporate clients favor stable organizations because they are considered reliable. Therefore, older corporations resist change (Michael and Freeman 1984), which may include failing to invest resources to reduce their GHG emissions. UPC age was calculated by subtracting the year of incorporation of each UPC from the year of the data. Data on year of incorporation are obtained from Mergent Online.

Methods

Generalized estimating equations (GEE), which are based on quasi-likelihood estimations, are used for the longitudinal analysis. The GEE model is an extension of generalized linear models to the case of correlated data. It accounts for autocorrelation (e.g. yearly measurements of the same firms) by estimating the correlation structure of the error terms, which makes it more suitable and accurate for longitudinal data analysis than generalized linear models (Hardin and Hilbe 2002; Liang and Zeger 1986).

Compared to random-effects model (REM), the GEE approach is preferable to examine these data for the following reasons. The selection of variance-covariance matrix for the repeated measures in GEE is not as critical as that for the REM (Hedeker and Gibbons 2006). Unlike REM, GEE produces robust standard errors regardless of the choice of the variance-covariance structure. This makes the GEE approach especially suitable to studies that are more interested in regression coefficients than in the variance-covariance structure (Rabe-Hesketh and Everitt 2004). Also, GEE provides regression estimates that are population-averaged rather than subject-specific (Hardin and Hilbe 2002; Hedeker and Gibbons 2006; Rabe-Hesketh and Everitt 2004). This feature fits with our research purpose of explaining the variations of pollution across UPCs. In all, GEE uses information more efficiently that generalized linear models (Hardin and Hilbe 2002). The GEE model specifies a first-order autoregressive correlation structure, which assumes the correlation between time points r and s to be $p^{|r-s|}$. This specification is congruent with the observed pattern of within-subject correlation matrix from our data.

Findings

The descriptive statistics and the covariance matrix are presented in Tables 1 and 2. Substantial variation on the variables of interest exists among the largest corporations in the US energy sector. With regard to resources under the control of top management in the UPC, total assets range from 78.6 USD million to more than 59 USD billion. Similarly, there is substantial variation in organizational complexity with the least complex UPCs holding ownership control over one power plant and no subsidiaries and subsidiary levels

Table 1. Descriptive statistics.

Variable	Mean	Std. Dev.	Min	Max
GHG emissions	1.22E+07	1.56E+07	407.91	76,800,000
Assets logged	9.044765	1.337687	4.364702	10.98682
Number of facilities	8.318182	8.614136	1	36
Number of subsidiaries	8.787879	9.661469	0	66
Number of subsidiary layers	1.674242	0.9768012	0	5
Political action committee contributions	107,740.4	163,688.3	0	819,699
Green score	25.07576	13.18606	2	49
Interaction green score with assets logged	225.5428	122.921	15.56582	496.4711
Western states with hydro facilities	0.0454545	0.2090924	0	1
Age of ultimate parent company	80.13636	44.97901	0	163

to the most complex with 36 power plants, 66 subsidiaries, and 5 subsidiary levels (see Table 1). Some UPC have more subsidiaries than plants because they diversified into other product lines and became conglomerates after neoliberal re-regulation. Finally, there is a wide range of total emissions among these large corporations ranging from 407.9 metric tons to 76.8 million metric tons of annual GHGs emitted.

The following interprets the findings reported in Table 3. As expected UPC size (H1), measured as the log of total assets, is negative and statistically significant ($p = \leq .001$) showing that larger UPCs have lower GHG emissions. This finding is consistent with the above discussion, which suggests that larger corporations have more incentives to contain their pollution. Incentives including being targeted by environmental movement organizations who expose high polluting behavior to the public including investors who may avoid investing in high polluting UPCs and voters who may pressure politicians to tighten pollution controls on UPCs. Larger UPCs also have better access to capital markets (e.g., bank loans) to obtain the resources to invest in pollution abatement technologies as bankers consider large corporations reliable clients that are likely to repay their loans.

Two of the three complexity measurements are statistically significant. As expected, the number of facilities (H2) has a statistically significant ($p = < .000$) positive effect on GHG emissions. The number of subsidiaries organized under the UPC (H3) also had a statistically significant ($p = < .052$) positive effect on GHG emissions. The number of subsidiary layers (H4) is not statistically significant. This suggests that dimensions of organizational complexity operate in different ways to effect GHGs. The statistically significant and positive relationship between GHG emissions and the number of facilities and the number of subsidiaries is consistent with the long-standing proposition in organizational theory that organizational complexity contributes to bounded rationality in complex organizations undermining managements' ability to control operating entities. However, caution should be taken before accepting this interpretation as in response to the economic crisis and declining profits in the 1980s, top management implemented computerized information processing technologies capable of monitor operating entities. Like earlier forms of technical control (Edwards 1979), computerized information processes technologies provide manager-engineers with the capacity to establish the outside parameters of operating decisions and monitor operating managers adherence to those parameters (Prechel 1994). Therefore, there may be other reasons for higher GHG emissions in complex UPCs such as strategic investments that advance their short-term capital accumulation agendas over environmental agendas.

Table 2. Correlation coefficients.

	GHG emissions/ Assets logged	Assets logged	Number of Facilities	Number of subsidiaries	Subsidiary layers	Political action committee contributions	Green score	Interaction green score with assets logged	Western states with hydro facilities	Age of ultimate parent
GHG emissions/Assets logged										
Assets logged	0.348									
Number of facilities	0.78	0.534								
Number of subsidiaries	0.303	0.370	0.257							
Number of subsidiary Layers	0.067	0.201	0.038	0.576						
Political action committee contributions	0.301	0.497	0.351	0.149	0.200					
Green score	0.107	0.013	0.063	0.094	−0.012	0.165				
Interaction green score with assets logged	0.226	0.299	0.182	0.227	0.043	0.299	0.866			
Western states with hydro facilities	−0.127	−0.137	−0.169	−0.163	−0.156	−0.118	−0.377	−0.369		
Age of ultimate parent company	−0.288	−0.243	−0.310	−0.185	−0.100	−0.044	0.010	0.004	0.252	1

Table 3. The effiects of ultimate parent company organizational characteristics and political behavior on GHG emissions in US electrical energy sector.

Independent variables	
Assets logged	−318,786 a
	91,701.3 b
	0.001*** c
Number of facilities	146,033.9
	11,753.24
	0.000***
Number of subsidiaries	21,410.5
	11,017.3
	0.052**
Number of subsidiary layers	−30,777.3
	105,157.1
	0.770
Political action committee contributions	0.7308256
	0.5890643
	0.215
Subnational state green score	−24,434.66
	14,495.38
	0.092*
Interaction variable	
Green score with assets logged	3,827.13
	1640.613
	0.020**
Control variables	
Western states with hydro facilities	417,726
	434,601.4
	0.336
Age	−3062
	1984.87
	0.123
Constant	2.67E+06
	837,780.5
	0.001***
Wald	246.44
Parent company years	131
Parent companies	66

a = Regression coefficient;
b = Standard error;
c = Statistical significance: *p <.1; **p <.05; ***p <.001.

PAC contributions (H5) are in the expected direction but it is not statistical significant (p = < .215). This less than desired level of statistical significant maybe due to the monopolistic power of UPCs in this economic sector that permits them to exercise control over markets without expending substantial resources on PAC contributions.

The coefficient for subnational green scores (H6) is also in the expected direct. Due to the small study group, this variable is considered statistical significant at p = < .092. State green scores are particularly important in the neoliberal era when the federal government shifted much of the authority over EPA enforcement to subnational states. States are also the site of greater political activism manifested as the Green New Deal in states with more progressive policy initiatives (e.g., California and New York) than the federal government. UPCs whose headquarters are located in greener states are also likely to make strategic decisions to control their GHG emissions to avoid media attention and public scrutiny that may threaten economic assistance provided by local and state governments (e.g., subsidies and tax credits).

The interaction of state green rank and assets (H7) is also statistical significant ($p = \leq .02$) and in the expected direction. When these variables are analyzed separately, they reduce GHG emissions. However, when analyzed as an interaction term they have the opposite effect. This suggests that the largest corporations are able to wield substantial political power. Greener states exempt the largest UPCs because they may threaten to move their corporate headquarters or production facilities to another state resulting in the loss of tax revenues and middle and upper income managerial and technical jobs. The managerial class may also use the resources under their control to fund media campaigns stressing the neoliberal claim that government interference in the economy undermines efficiency. Together, these corporate-state relations create a political environment where elected officials hesitate to enforce states' environmental controls on the largest UPCs as it may undermine their chances of reelection.

The control variable for Pacific and Northwest states, which obtain more energy from hydropower than other regions, is not statistically significant. The control for UPC age inertia is also not statistically significant.

Conclusion

The analysis supports the central tenets of organizational political economy. The historical contextualization summarizes how corporations mobilize politically and exercise their instrumental power (i.e., use of resources to affect political outcomes) in the 1980s and 1990s to redefine the political-legal arrangements in which they are embedded. Neoliberal re-regulation increased organizational and financial flexibility, which permitted corporations to advance their capital accumulation agendas over environmental agendas. In addition to weakened the Clean Air Act and other environmental laws, the emergent political-legal arrangements extended corporate property rights and relaxed antitrust enforcement, permitting corporations to restructure as the multilayer-subsidiary form and increase their size. Organizational changes also include the increased use of stock and stock option as executive compensation. These organizational and political-legal arrangements place more organizational resources under the control of the largest ultimate parent companies thereby increasing the structural power of top echelon of the managerial class (Prechel 2019; Prechel Forthcoming). The emergence of the managerial class who are both owners and managers have incentives to make strategic decisions to not implement pollution controls or shift to renewable energy as these investments raise costs, which typically results in lower stock valuations, including the value of their own stock.

The quantitative analysis shows that ultimate parent companies in the electrical energy producing sector with more organizational complexity emit more GHGs. The analysis also shows that political embeddedness of UPCs in subnational states with fewer environmental controls is associated with higher GHG emissions. In contrast to plant level analysis showing that the largest plants pollute at a higher rate (Grant et al. 2002), UPCs with the most assets have lower GHG emissions. This finding must be contextualized as the study group consists of the largest electrical energy producers in the US. Thus, all of the UPCs in the analysis are large. However, the largest UPCs in the study group are much larger than the smaller UPCs. The organizational political economy perspective suggest that the substantial UPC size variation (see Table 1) explains the interaction between UPC size and political embeddedness. Specifically, if political elites do not exempt the largest UPCs from environmental regulations, the managerial class may exercises their political and economic power by threatening to move their corporate headquarters and production facilities to another state resulting in job losses and tax revenues, which may undermine the legitimacy and reelection of political elites.

It is noteworthy that the focus on the largest UPC in this economic sector resulted in a relatively small study group and the data are limited to a two-year time frame. Thus, future studies should focus on including more UPC and examine these relationships over a longer time period.

By examining the unchallenged and taken-for-granted assumptions (Freudenburg 2006) concerning variation in corporations, the analysis provides information on the "midstream" component of the social structure where strategic decision-making authority is located. In this way, this study provides important insights into where in the social structure to target creative solutions to climate change. Specifically, the focus on this critical link between macro-level arrangements and production facilities provides an alternative to the assumption that market-based solutions (e.g., carbon trading) and post-production strategies (e.g., carbon capture and sequestration) are the only viable solutions to reduce GHG emissions from energy produce by fossil fuels. In this way, organizational political-economy opens up new intellectual spaces and avenues for environmental policy reform.

The climate change crisis raises critical questions: Will the creative tendencies in capitalism (Schumpeter 1942 [1950]) reemerge to limit the production of GHG emissions? Or, will these creative tendencies be suppressed by the current neoliberal fossil fuel regime?

Although the threat of climate change to society is qualitative different from the financial risks that resulted in the Great Depression and Great Recession, the corporate structures used by the managerial class to create risks are similar. Like the early 20th century when managers and owners used the holding company to engage in behaviors that created risks contributing to the Great Depression (Berle and Means 1932 [1991]), the contemporary managerial class lobbied Congress to restructure the modern corporation as the multilayer-subsidiary form. The increased organizational and financial flexible of this multilayer-subsidiary form along with the lack antitrust enforcement resulted in strategic decisions that increased the size of the modern corporation and made it viable to diversify into the high-risk financial sector and other economic sectors thereby draining assets from the UPC's operating entities. After making these strategic decisions, members of the managerial class claim that the corporation does not have the resources to meet environmental regulatory standards. Although society is recovering from the high-risk behavior of giant financial UPCs, by ignoring the ecological crisis, giant electrical energy producing UPCs create an even greater risk to society as much damage from climate change (e.g., ocean warming and melting polar ice caps) cannot be reversed for centuries, if ever.

By focusing on the relationship between the midstream component of the social structure and environmental pollution, organizational political economy offers a different perspective to understand the production of GHG emissions. Most quantitative analyses of pollution focus on plants and nation-states. Whereas the focus on plants provides information on how plant characteristics and communities intersect to affect pollution, the focus on nation-states is driven by how politics affect environmental treaties and conventions (Heede 2013). By focusing on the organizational and political-legal arrangements of the modern corporation, organizational political economy provides information that can be used to increase pressure on the managerial class, institutional investors, and large individual investors to reduce the polluting behavior in UPCs operating entities. This focus also creates incentives for the managerial class and large investors to be part of the solution. Policies, shareholder actions, and litigation of UPCs had significant effects on controlling tobacco production and distribution (Heede 2013). Comparable efforts can be directed toward UPCs in the energy sector by creating incentives to invest in pollution abatement technologies and renewable energy thereby making it possible to leave more fossil fuels in the ground. In this way, this research responds to the call by climate scientists (Stern et al. 2016) for greater emphasis on how organizational and institutional arrangements can be incorporated into a science of human-environment interaction.

Notes

1. Although the empirical analysis here examines GHG emissions, this literature review includes toxic emissions as the organizational drivers of both types of pollution are expected to be similar.
2. In the recent version of the CARMA data, CO2 emissions "is within 20% of the true value about 75% of the time" (Ummel 2012).

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Notes on contributor

Harland Prechel is Professor of Sociology and College of Liberal Arts Cornerstone Fellow and Energy Institute Fellow at Texas A&M University. His areas of research are the corporation, economic, environmental, and political sociology. Prechel's research program focuses on corporate-state relations with particular focus on state power and corporate power. There are two interrelated themes in his current research: How corporate-state relations and corporate characteristics affect financial malfeasance and environmental pollution.

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