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The Performance of Sustainability in U.S. Plastics and Associated Industry Associations

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The Performance of Sustainability in U.S. Plastics and Associated Industry Associations

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by

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ABSTRACT OF THE DISSERTATION

The Performance of Sustainability in U.S. Plastics and Associated Industry Associations

by

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Doctor of Philosophy, Graduate Program in Sociology
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Dr. Christopher Chase-Dunn, Chairperson

The question of sustainability has been important for plastics firms and their industry associations for decades, however there has not been much social science scholarship specifically exploring how plastics firms, or their industry associations, perform sustainably. This project uses 2016 Toxics Release Inventory (TRI) data, financial data from Hoovers, and data on industry associations to answer questions about the plastics firm and industry association characteristics most associated with toxic emissions.

After a theoretical exploration of sustainability in Chapter 2, multilevel regressions are conducted in Chapter 3 demonstrating that plastics firm financial and structural variables (Revenue, Risky Firm Credit, Subsidiary Levels, and Facility Employees) are significantly associated with increases of Planned Toxic Emissions. Specifically, both Planned and Fugitive Emissions increase as a function of firm Revenue and Subsidiary Layers. In addition, a cubic function of Facility Employees demonstrates increases in Planned and Fugitive Emissions per employee for smaller facilities, and decreases per employee for larger facilities. These findings indicate that the size, wealth, and structure of plastics firms affect how sustainability is practiced.

Chapter 4 explores what is currently known in the social sciences about industry associations and highlights the role they play as knowledge collectivities in terms of sustainability. Industry association variables on membership, the amount of sustainability information on their websites, and whether the association has a sustainability committee are added to the previous multilevel regression models. Industry association membership is associated with higher Planned Emissions and lower Fugitive Emissions, firms that are members of industry associations with high sustainability rhetoric tend to have lower emissions, while member firms of industry associations with sustainability committees tend to have higher emissions. So, industry association membership appears to be associated with effects on member firm emissions, although not always in predicted ways.

This project furthers the study of organizations and manufacturing by focusing on plastics, an important US manufacturing industry, by looking at both Planned and Fugitive Emissions, and by dealing with data for both publicly and privately owned organizations, including very large versus very small organizations.

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Plastics is the third largest manufacturing industry in the US, it has more than 42 industry associations that coordinate it and represent it to government, and sustainability is a very controversial topic that is being dealt with all through this and many other industrial sectors. When reading *The Plastics News*, for example, one sees article after article on the involvement of plastics industry associations in forming and implementing government regulations on toxic emissions, in the development of new knowledge and technologies to increase the recyclability of plastics, and in representing plastics industry viewpoints to the public, particularly its very specific views on the environment. Sustainability ebbs and flows through all of these topics as plastics firms grapple with the demands of stakeholders, government regulations, and the beliefs of employees regarding sustainability.

One thing plastics firms (and indeed, all organizations) are struggling to do is to balance demands to become more sustainable with the many other demands made on them by the organizational environment. Demands for increased sustainability, and the drive to demonstrate this, are signals of the development of sustainability as a legitimacy requirement across the economy. Legitimacy is the sense of belonging, legality, and appropriateness that firms engage in to a greater or lesser extent as part of doing business. For example, having a physical place of business is a very important aspect of legitimacy for many firms, however how clean, orderly, and attractive the shop needs to be depends very much on clientele expectations. Matching firm behavior and setting to customer interests and requirements is a never-ending negotiation that is made more challenging based on the changing interests of people, as well as technological developments. The fundamental notion that underpins this dissertation is about whether sustainability demands manifesting from the organizational environment form legitimacy requirements for plastics firms and if so, how well firms address these.

Sustainability, previously, environmentalism, is an ideal lens for studying organizations in the current period, partly because it is a value that is not equally held by different people, a legitimacy requirement that is not fully enacted on organizations, although, it is hoped that it eventually will be a universal value and a universal legitimacy requirement. Sustainability, unlike many other legitimacy requirements, is not something that directly affects the customer experience the way minimum quality expectations do, or different forms of customer service may because it is a value and activity directed at the preservation of access to dispersed resources, such as health and clean air, as well as the general availability of natural resources that can become commodities such as oil, timber, and water. Unfortunately, in the current political and administrative formation, there is often not any good way to examine sustainability as it pertains to a specific firm, or to hold the firm accountable for it. It is also difficult to judge the relative balance of what comprises good sustainability. By some accounts, the best sustainability is to not engage in manufacturing at all, however, most people understand that modern life would not be possible without manufacturing, and so the question is always, how much sustainability is enough for a clean environment without making manufacturing impossible? The continual negotiation of the balance point between devoting adequate resources to preventing toxic emissions, for example, and between operating a business competitively is a very rich area from which to explore how organizations work.

The basic way I explore how and whether sustainability demands form legitimacy requirements is the relationship between sample firm toxic emissions and various independent variables. For example, if a firm operates in a more sustainable way when it has more available resources, this indicates that sustainability is likely a legitimacy requirement of the wealthy: it indicates that poorer firms would likely operate more sustainably if they could. Similarly, if a firm can become more sustainable on the basis of participation in social organizations, like industry associations, this may tell us something not only about the power of industry associations, but also about the power of networks and socialization to influence legitimacy requirements and how they may provide means to resolve the requirements.

This dissertation examines these questions about plastics firms, industry associations, and sustainability and more through one theoretical and two empirical chapters. First (in Chapter 2) I look at applicable sociological theory by comparing two popular global climate change theories, Treadmill of Production (TOP) and Ecological Modernization (EM), to two popular organizational theories, Resource Dependence and Neo-Institutionalism. Because TOP and EM make many assumptions about the role of manufacturing in hastening or preventing global climate apocalypse, they become a fertile area to explore the sociology of organizations through the organizational theories. This exercise will review some general trends of thought about the nature of sustainability and organizations, and help ground the research theoretically.

Next in Chapter 3, I use multi-level modelling to explore whether certain specific characteristics of plastics firms like size, resources, and structure, have any relationship to toxic emissions, the dependent variables (Planned Emissions and Fugitive Emissions). One might expect, for example, that firms with limited resources would cut back on peripheral operations, like sustainability programs and/or purchasing or repairing sustainability equipment, leading to increased toxic emissions. Resource-related and structural independent variables are therefore used, including credit, revenue, number of subsidiary levels, and number of facility employees. In some ways, this analysis is related to neo-classical economic thinking where availability of resources is seen as the most important factor to consider when attempting to explain human or organizational behavior.

In Chapter 4 we turn to more sociological reasoning by using independent variables related to industry associations to explore plastics firm toxic emissions (dependent variable). The new independent variables are centered around firm membership in industry associations, and aspects of the associations themselves, for example, how much sustainability rhetoric the industry association has on its public website and whether it has a sustainability committee. These variables are considered Institutional because membership in an industry association represents a non-economic choice made by firm owners and management, a decision likely based on such things as tradition, habit, and networks. It will also be demonstrated that industry associations have many institutional characteristics, especially as far as they serve as knowledge repositories and distribution networks for member firms.

Importance of Work

This work is important because it examines areas of organizational life and the economy which are greatly understudied: the plastics industry and industry associations. It also introduces novel data derived from Hoover's, a former subsidiary of Dun & Bradstreet which features private organization data. This dissertation introduces one of the few quantitative analyses of industry association variables, and it comprises one of the few analyses of the Toxics Release Inventory (TRI) based on one industry (plastics) rather than the far more popular analysis of large conglomerates that engage in many industries. Finally, this analysis is one of the few that includes medium and small businesses as well as large firms.

Assuming a general unfamiliarity with plastics and industry associations, this introduction will next review some basics on the two, as well as a short history of environmentalism presented in terms of organizational legitimacy.

A Very Short History of Environmental Legitimacy

Although most sources cite the beginning of the modern stage of the negotiation of industry environmental legitimacy as the publication of Rachel Carson's Silent Spring in 1964 (Hoffman 2001; Dowie 1996) it can be traced more than 150 years back to the formation of corporate law in the US with the idea that the negative social and environmental results of firm success should be managed by the community and government, in effect externally to the company (Perrow 2002; Banerjee 2008). The assumption since that time has been that a firm has limited responsibility for emissions to air, water, and land, and the primary fight of environmentalism has been to force firms to take back the responsibility for negative externalities in order to maintain healthy ecosystems. Taken from this perspective, the fight for national parks in the early 20th century was a kind of environmentalism, demanding as it did that specific lands be set aside and not developed for industrial or residential uses (Dowie 1996). Considered in this context, one significant point about the 1960s and 1970s sustainability fight is that this was when environmentalists successfully pushed environmental care forward as a factor of firm legitimacy as several important pieces of environmental legislation were passed and a new agency with broad power over how firms interact with the environment was created: the Environmental Protection Agency (EPA) (Barley 2010; Dowie 1996).

Of course, for regulations to be effective, they need to be implemented, as environmental organizations discovered in the 1980s when they found themselves forced to sue the US government to coerce it to follow its own environmental law (Dowie 1996). In effect, the environmentalists had succeeded in pushing forward a demand for environmental legitimacy, however the firms themselves were able to resist implementation through co-option of aspects of the federal government itself.[1] Here we see a break between what some might consider a required factor of legitimacy (compliance with the law) and an environmental protection system that goes unimplemented (Perrow and Pulver 2015; Dowie 1996). If formal environmental regulations are not observed, then the law itself becomes ceremonial, and firm sustainability rhetoric becomes even more suspect as evidence of environmental commitment.

Reagan's push to roll back environmental regulations and defund the EPA in the early 1980s represented an attempt at retrenchment which was not entirely successful however, based on public outcry (Hoffman 2001). This appears to indicate that some level of environmental commitment on the part of the government, and presumably, firms, was required for legitimacy by the 1980s. Despite environmentalists' frustration with a government that that did not fully enforce environmental law (Dowie 1996), firms that were involved in large and deadly industrial accidents, for example, Union Carbide and Exxon, saw their legitimacy with the public and shareholders suffer as reflected in sales and in terms of stock performance, a trend which continues for large brands[2] (Vidovic and Khanna 2007; Khanna and Damon 1999). It is important to note, however, that many firms have industrial accidents without much attention or many ill effects (see for example, Rich 2016). In effect we might say that environmental compliance became a legitimacy requirement through the 1990s to the point of a minimal level of legal protections around human life and certain natural areas, and that this added up to less than what

[1] It should be noted that this was not the only response of business to the success of environmentalism and other popular programs. Barley traces a surge of business-oriented peak organization building around lobbying and regulation capture designed to counteract what was seen as environmentalist/leftist overreach in the 1960s and 1970s (2010).

[2] We will see later that the Union Carbide event had a great impact on US manufacturing, and particularly on the plastics and chemicals industries.

environmentalists saw as appropriate, and much more than what industry thought was appropriate.

Environmental organizations settled into a relative cozy relationship with industry based on neo-liberal reform in the 1990s (Dowie 1996) however climate change pushed the environmental question back into play soon after. Claims of anthropocentric climate change completely shifted the dynamic of the negotiations (Dunlap and McCright 2015). Under global warming, the previous détente requirement of manufacturing to "do no harm" as defined by a minimal enforcement of federal and state law grew into doubts about the nature of the modern economy itself. The threat of climate change is defined clearly by the *Treadmill of Production* (Gould, Pellow & Schnaiberg 2008): the cyclical nature of industry, which provides for the needs of everyone in the developed world and most people in the developing world, will itself cause the devastation of human society through the release of carbon, leading to ongoing catastrophic weather events caused by a warming planet. To be a "believer" in global climate change infers a willingness to engage in some level of economic restructuring to prevent societal devastation. To be a climate "denier" infers a suspicion about the true nature of the climate change campaign and resistance to any effort to restructure a modern economy dependent on fossil fuels.

As a legitimacy demand, then, the pro-environmental side has increased the depth and scope of its claims, which may explain the rather extreme means climate deniers have embraced in their side of the battle. Large amounts of money have been invested in alternative research agendas, lobbying, advertising, and political campaigns against government action on sustainability (Dunlap and McCright 2015; Oreskes and Conway 2010). Although many firms have sustainability programs on public display, there are also many large corporate donors to climate denying efforts and in some cases these are the same entities (Dunlap and McCright 2015; Goldman and Carlson 2014). This implies that there may be a difference between rhetorical sustainability as a feature of corporate legitimacy and sustainability activity in terms of production.

Sustainability is therefore an excellent means through which to explore the gap between rhetoric and action in organizational theory because sustainability functions as a modern legitimacy requirement foisted on firms (from their point of view) by the public and government which appears to require them to change the way they operate and requires increased expenses in the form of new equipment, retraining, and the clean-up of industrial sites. It is presumed that the temptation to engage in ceremony rather than actual change must be very strong in the sustainability arena because not only are the stakes high in terms of financial investment, but from the denialist point of view, the entire situation is an extremely large and inconvenient fad that will blow over in the long run. It is, after all in the firm's interest to only act substantively on those demands from which it cannot escape through skillful means (Pfeffer and Salancik 2003 [1978]).

One of the largest industries in the US, plastics manufacturing is no stranger to environmental concerns of all types as it provides some of the products many people most associate with modern life: computers, ready-made food, and medical equipment.

The Plastics Industry

Plastics have grown geometrically in importance since first discovery (Thompson et al. 2009 2009), replacing traditional use of glass and metals (Ruth 1998), and disrupting markets as plastic goods replace more traditional materials in industry after industry, starting with tortoise shell combs (Freinkel 2011) in the late 19th century to the replacement of wire metal shopping carts in the present day (Jansen 2016). In addition, the plastics industry also makes possible a whole range of products that have no natural reference group, like computers and medical equipment, leading to its place as the third largest industry in the U.S. (Andrady 2015). In fact, the growth rate of plastics has been estimated at 8% per year since the 1950s, and is projected to follow a geometric progression into the future (Geyer, Jambeck and Law 2017). In a sense, the problem of what to do about plastics is just another iteration of the paradox of modern life where a thing which is of great benefit to many people also causes enormous environmental consequences (as is the case with oil and global climate change, and hydrocarbons and the ozone layer). In this case, plastics have made modern manufacturing possible, including the provender of food and useful, inexpensive consumer goods to millions of people (Thompson et al. 2009 2009). If all combs had to be made of tortoise shells, for example, there would be far fewer combs, and even fewer tortoises.

Plastics has been, and still is, at the center of many environmental scandals and concerns over the decades, however possibly the most important one is the adverse effects of discarded plastic trash in the oceans. Plastics do not decompose organically, meaning that their molecules do not break down into component parts. Instead, plastic breaks into smaller and smaller pieces of itself as the molecules continue to hold form for an undefined amount of time (Barnes et al. 2009). This means that plastic accumulates all over the world in seen (as garbage) and unseen ways (as microplastics) (Barnes et al. 2009). Microplastics enter the food chain when fish eat them, animals get caught up in discarded fishing nets and plastic bags, pieces of plastic carry micro-organisms across the oceans, and a vast amount of plastic garbage swirls in miles-long gyres, or whirlpools of trash in rotating ocean currents. In fact, finely tuned measurement of the Anthropocene is partly defined by deposits of types of plastic waste across the world, and particularly on all areas of the sea floor (Zalasiewicza et al. 2016).

For many years, though, plastics firms have had industry associations to help them meet these and other challenges, and not only technical solutions, but also in communicating with the public and government. The plastics industry is distinguished by the very large number of industry associations that serve it; currently there are at least 42 industry associations affiliated with some subindustry of plastics, or the entire field.

Industry Associations

Industry associations[3] are the most important organizations most people have never heard of. Industry associations are formed by firms for a great variety of purposes, from the need to coordinate an organizational field to the need to address a specific and often timely issue of concern (ad hoc organizations) (Barley 2010). For example, industry associations assist with the very important activity of standardization, which is of great value to consumers, they create barriers to entry that can maintain product quality, and they provide expert information to regulators and legislators on how to effectively understand the nuances of the various products and processes that government deals with.

The problem is that industry associations can also comprise well-funded and powerful organizations dedicated to protecting an industry that is threatened by shifts in public expectations, or legitimacy demands. For example, the American Chemical Council (ACC) and PIA/SPI have formed the American Recyclable Plastic Bag Alliance to fight consumer action to ban single use plastic bags (The Plastics News 2011). The Council for Tobacco Research and the Tobacco Institute worked to attack scientific evidence of the harm of smoking, while at the same time promoting smoking as a positive activity (Oreskes and Conway 2010). The Global Climate Coalition (GCC), organized by the National Association of Manufacturers (NAM) was instrumental in blocking the US from ratifying the Kyoto Protocol. Most recently, restaurant

[3] Although industry associations are the main topic here as we concentrate on manufacturing, it is important to keep in mind that associations exist to serve almost every known area of the economy, including professional associations like the American Medical Association (AMA), and the American Psychological Association (APA), and service associations, like the United Association of Plumbers and Pipefitters (UAPP), or the National Council of University Research Administrators (NCURA).

industry associations were a significant part of the industry groups that pressured governors to rush into the premature reopening of the US economy in May 2020 (Lieb 2020) in the face of scientific evidence that this would increase COVID-19 rates, and therefore increase the number of American deaths.

A cogent example of the influence of industry associations and their role in protecting supporting industries emerged rather recently. National Public Radio (NPR) recently broke a story that questions the veracity of PIA/SPI ongoing efforts to promote the viability of plastics recycling, contending that consumers and government have been misled by one of the two dominant plastics pan-industry associations. NPR charges that the PIA/SPI has been actively promoting false narratives of plastics recycling for decades (Sullivan 2020).

Much of what the reporting relates about plastics recycling has been known within the industry and by those who observe it closely, but was not necessarily widely known by the public. For example, it has been well-known that virgin resins are easier to work with and produce superior products compared to currently available recycled resins (Al-Salem, Lettieri and Baeyens 2009; Curlee 1986), and that this situation has been exacerbated by new resin producing facilities that have recently come online (Hocevar 2020). It has been well-known that post-consumer plastics are difficult to recycle because plastics formulas are not standardized between products: they are generally created using designer formulas with very different molecular and chemical components (Curlee 1986; Andrady 2015; Hocevar 2020). The plastic that makes film grocery bags is created through a completely different process from the plastic of a margarine tub, for example. Further, multiple additives are combined with various plastics to design the product to meet specific needs, for example, decreasing thermal degradation, or increasing strength, etc. (Andrady 2015), and finally, labelling also contaminates many post-consumer plastics (Hocevar

2020). One cannot, therefore, just gather sundry used plastics products together and melt them down into something useful, because while these materials may appear to be similar, they are not the same. This leads to the necessity of the expensive process of sorting plastics into categories that could potentially be recycled together (Al-Salem et al. 2009; Curlee 1986; Gibson and Pratt 2003).

The result over the years has been that despite the development of a recycling industry, primarily for PET and HDPE plastics, the actual amount of recycling, particularly in comparison to the tonnage of plastic waste has been "disappointingly slow" (Gibson and Pratt 2003:8). California PET plastic bottle recycling has been highly subsidized by the state government and curbside recycling shows steady annual losses for most local governments (Gibson and Pratt 2003). In fact, some California municipalities collect and sort plastics only to send them to landfills because the salvaged materials cannot be sold (Gibson and Pratt 2003), a problem that has been exacerbated recently (Hocevar 2020).

Previously, much of the plastics materials processed by US recyclers was sent to China, where it was generally assumed that the Chinese were sorting, recycling and using the tons of plastic wastes that were sold to them, although, in fact, some amount of plastic scrap sent to China was also landfilled (Hocevar 2020). In 2013 the Chinese began the gradual restriction of US plastic waste imports with the Green Fence and National Sword policies, which disrupted the US plastic recycling industry (Resource Recycling News Editorial Staff 2018). Other Asian countries followed suit, causing the value of recyclable materials to plummet far below the costs of gathering and preparing them (Semuels 2019). Over the ensuing months, hard truths about the nature of plastics recycling in the US have emerged: without the Chinese to buy up the recycled waste, there has never been a strong market for it in the US. This is even more true now, due to ever-decreasing prices of virgin resins caused by massive new plastic production facilities that have recently begun operation (Hocevar 2020).

What the NPR project revealed was not so much the truths about plastics recycling, which had existed in a rather piecemeal fashion in other places, as has just been demonstrated. The NPR accounts told a new story about plastics industry associations, one which highlighted the involvement of the Plastics Industry Association (PIA/SPI) one of the two plastics pan-industry associations, in what amounts to a cover-up of the true nature of the recycling industry in the US (Sullivan 2020). This new information categorically states that it has been a general understanding of the plastics industry since the 1970s that plastics are unlikely to ever be recycled in practical or efficient way (Sullivan 2020). Rather than honestly providing this information to the public, however, the PIA/SPI has spent millions of dollars on advertising over the years teaching the public that plastics are recyclable and that post-consumer plastic is valuable in spite of evidence to the contrary (Sullivan 2020).

That an industry association, an organization designed and run to protect an industry, would step up with false information to protect that industry from an existential threat should not be too surprising, especially given that industry associations are partly designed to protect their supporting industries. In fact, we know little of industry associations as a class of organization outside those times when they have moved, sometimes fiercely, to protect their industries (cigarettes, oil, plastic bags).

When one considers the power of industry associations in the US political system (Barley 2010), however, the study of industry associations appears to be a requirement to understanding both what the modern world is, and what it is not; what changes and what never seems to change. If we look closely at many impasses where the popular will cannot seem to be manifested politically, we will often see industry associations there, for example, global climate change (the Global Climate Coalition (GCC), the American Petroleum Institute and others), gun control (National Shooting Sports Foundation), and prescription drug costs (the Pharmaceutical Research and Manufacturers of America). Understanding industry associations may not only shed light on an interesting organizational form, but also on a class of organizations with great political influence in arenas of great interest to many consumers. It is hoped that this dissertation will shed some light on the nature of industry associations, an important but understudied area, as well as plastics firms.

Chapter 2, Environmental and Organizational Views on Sustainability in Sociology

Many environmental sociologists and others express their assumptions about the nature of global climate change and the industrial system by choosing one or the other of two theories, the Treadmill of Production theory (TP), or Ecological Modernization theory (EM) (Rudel, Roberts and Carmin 2011). Both of these theories recognize that much environmental degradation comes as a result of firm-level manufacturing activity, which comprises the basic way modern human beings feed and clothe themselves, and inhabit the world. In fact, despite the fact that these are macro level theories, drawing conclusions about global issues, both theories are primarily based on assumptions and observations about the meso-level manufacturing system which creates the majority of pollution through both direct creation of goods, and by providing the products that create pollution through consumer use (such as airplanes, automobiles, and tractors). Intrinsic to these theories, then, are meso-level manufacturing organizations, as well as the micro-level consumers who purchase their daily needs from companies.

The macro assumptions made in these theories about manufacturing can therefore be examined by using meso-level organizational theory as a lens. This chapter mainly uses Resource Dependence theory and Institutionalism (including Neo-Institutionalism), mainstays of the sociology of organizations, to unpack many of the assumptions behind TP and EM.[4] This is important because it is the assumptions made about meso-level companies and organizations that allow these macro-level theories to forecast the futures that they do. Do these assumptions hold up to meso-level organizational theoretical analysis?

[4] Although this chapter shares many of the observations of Rachel Shwom (2009), it was independently conceived of and deals more specifically with issues of Institutionalism than her very informative and worthy work.

TP, for example, observes that the capitalist manufacturing system, driven by the requirement of profit, appears to engulf every human society that it comes into contact with, and cannot stop organizing itself around new opportunities to create goods and services to sell (aka entrepreneurship). Based on this assumption, TP forecasts that the capitalist system will continue on in increasingly manic cycles of resource use and depletion until there is nothing left and human society as we know it will no longer be possible. EM on the other hand, assumes that organizations are so strongly affected by institutional forces and the surrounding culture that companies will willingly give up advantage over competitors in order to welcome in a new sustainable world. Resource Dependence and Institutionalism both have a great deal to say about these assumptions, and in the process of examining TP and EM we may come to a better understanding of how companies function as well.

Resource Dependence theory predicts leadership motivation and strategies in dealing with the organizational environment and Institutionalism describes the effects of the institutional environment on organizational function and change. I will argue that the range of organizational behavior, as explained by Resource Dependence and Institutionalism is far wider than either TP or EM appear to recognize, and that this variability puts both of their general conclusions in doubt. Ergo we cannot say, as TP would do, that the world will end in a resourceless waste because as Resource Dependence explains, it is in the nature of companies to survive, to reproduce themselves, not necessarily to produce goods. We also cannot say that companies will effectively implement sustainability as EM insists, just because it is fashionable and much talked about in society or even within the company, because the push to change organizations is often counteracted by protective mechanisms that deflect actual change in favor of ceremonial processes.

Specifically, this exercise will help us hone in on the nature of company[5] (as opposed to organizational) change[6] as applied to the sustainability context, and the problems of effecting change as conceptualized by executive leadership through various levels of management to the shop floor, where production, and emissions, happen. The resulting conceptualization will inform empirical chapters 3 and 4, which attempt to test for these processes in plastics company financial and emissions data.

The Macro Theories

Introduced in the 1970s by Allan Schnaiberg, TP presents a logical, but also almost visceral view of growing environmental devastation brought on by the capitalist "commodity machine" (Smith and Lopes 2011; Gould, Pellow and Schnaiberg 2004). TP contends that the endless search for profit required by the capitalism causes a continual expansion of the industrial system, leading to the input of more and more raw materials for conversion to marketable products and waste. Even advances in technology which make industry more efficient by saving energy and materials lead to the Jevons Paradox where such savings are simply plowed back into the company to feed expansion, creating ever more production and therefore, increasing emissions, rather than diminishing them (Rudel, Roberts and Carmin 2011; York and Rosa 2003a). According to TP theorists, this unending conversion of resources to wastes, both through emissions and discarded products, will eventually cause sufficient environmental destruction to make the earth uninhabitable.

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[5] By company I mean any formally organized group of people dedicated to providing a good or service in exchange for currency. In this dissertation, company will most often refer to for-profit plastics organizations, both public and private, of all sizes, from single facility concerns to large multi-national multi-subsidiary behemoths. For the sake of readability, company and firm will be used interchangeably.

[6] Company versus organizational change is delineated here as it seems that the profit motive of companies strongly conditions the nature and possibility of organizational change in manufacturing. It seems important to look at change in the for-profit sector specifically as this is a very important case for environmentalism.

EM, introduced in the 1990s by Arthur Mol and Gert Spaargaren, presents a nuanced view of the same situation: essentially, EM agrees with the potential for deleterious consequences of the treadmill of production, but disagrees that total despoliation of the environment is inevitable. EM presents a more institutional view of the business world (Shwom 2009), in which environmentally efficient technologies and procedures will be naturally adopted into business practice as the result of the awareness of resource limitations, environmental degradation, and the developing pro-environmental attitudes of society (Mol and Spaargaren 2005; White 2006). This includes a move toward pricing waste into the production cycle, thereby creating a cost to pollution that results in firms working to minimize emissions (Shwom 2009). Such changes will be sufficient to prevent or effectively contend with the effects of global climate change and other environmental harm, according to EM thought.

These strong assumptions about firm economic and institutional behavior can be unpacked using Resource Dependence theory and Neo-Institutionalism, which are ideal for this analysis because each deal with very different aspects of organizational behavior.

Resource Dependence

The sociology of organizations has produced a rich literature on the nature of companies and organizational behavior, including the classic treatise on resource dependence, *The External Control of Organizations: A Resource Dependence Perspective* by Jeffrey Pfeffer and Gerald Salancik (Pfeffer and Salancik 2003 [1978]). What Pfeffer and Salancik emphasized most was the simple observation that all firms require resources to survive, and all firms transact with the organizational environment to obtain these resources. Organizational sociologists often discuss the primary directive of firms to survive, however, they often neglect the impulse to thrive which comprises part of the need to survive. The need to thrive emerges in the drive for profit, which became a legal requirement for public firms to seek as a result of Dodge v. Ford Motor Company in 1919 (Supreme Court of Michigan 1919), and has been reaffirmed repeatedly since. Profit is a resource that can be used to acquire further resources (like binding employees to the company through salaries, binding investors to the firm through dividends, or the purchase of needed items and services) or it can be re-invested for use later, therefore profit assures current survival, and can be put aside for future firm survival.

The drive for resources causes firms to engage in power relationships based on access, which Pfeffer and Salancik term "interdependencies" (Pfeffer and Salancik 2003 [1978]). An interdependency is the relationship between two or more firms where one is dependent on the other for access to a resource. A simple and common interdependency is the payment of rent for access to property and buildings. The firm that owns the land receives payment for use of the land, and can raise rent, clear the current tenants, or use the land for its own purposes. The renting firm owes payment for use of the land and, given a weak real estate market, is subject to the interests of the landlord. In this power relationship, it is obviously better to be the landlord than the tenant, and Resource Dependence says that firms will always try to be the landlord, or seek to be the more powerful player, in order to maintain best access to resources and the opportunity to make better choices on behalf of the firm in the future.

Resource Dependence theory offers a roadmap to understand something of how organizations perform sustainability because it outlines and offers plausible explanations for organizational behavior. Using Resource Dependence as a tool, we can predict that firms will engage in sustainable practice when it is financially useful to do so, or perhaps, when it does not hurt the financial outlook. We can also predict that a certain number of demands for sustainable behavior will conflict with the drive toward resource acquisition or profitability, and will therefore be seen as potential interdependencies to be avoided. We would expect to see a number of firm maneuvers directed toward government and public demands for sustainable behavior, including efforts to ignore the problem, limit communication, influence regulation, seizure of expert opinion, etc.[7] How will this understanding fit with the predictions of the popular sustainability theories (TP and EM) regarding roadmaps of organizational response to a social environment that calls for sustainability?

Resource Dependence and the TP

Resource Dependence and the TP agree on one very important aspect of life for companies in the modern world: they are under constant pressure to survive. TP take the birds-eye view of a system designed to continue production at a very high rate based on the financial and legal system established by capitalism (Gould et al. 2004), while Pfeffer and Salancik (2003) address the actions of organizations as they seek to reproduce themselves by positioning products to meet market demand, trade goods and services for currency, attempt to gain advantage from interdependencies and avoid interdependency costs. Competitors are simply other firms doing similar things, also looking to extract resources from consumers in exchange for goods or services and avoid harmful interdependencies (Wright 2004) so we can see that Resource Dependence describes in some detail what TP predicts. Because consumers in any particular market are not endless, firms must compete with each other to make the transactions needed to acquire the resources to survive. This competition is itself the treadmill, because no firm can exist for long without awareness of its niche and competitors, how conditions may be changing around it, and purposive action to reproduce itself, one transaction at a time. Resource Dependence therefore offers information on the nature of life inside the treadmill, and appears to agree on the

[7] These maneuvers are described in detail by Pfeffer & Salancik (2003), although not in reference to avoiding sustainability issues.

basics of organization behavior and need to survive and acquire profit in a competitive environment.

Resource Dependence, however, with its emphasis on interdependencies, reveals details about how firm behavior can be molded by more powerful forces, even against the strong forces of the treadmill. A basic example of this is the role of government within an industrial field. Governments are probably the most obvious example of force that can create potentially very strong and most lasting interdependencies. For example, insofar as governments provide funding opportunities to firms, they can create interdependencies where the firm must comply with additional government requirements in return for access to resources. The US Federal Government, for example, has many additional regulations for federal contractors, including a federal minimum wage and increased requirements against discrimination against the disabled, among others. Despite these additional requirements, many firms step up to do business with the Federal Government, accepting many interdependencies along the way.

Where a government is able and willing to enforce increased sustainability law, therefore, as the EU does, firms will largely comply, and therefore the interdependency aspect of Resource Dependence can be an example against TP under a strong pro-sustainability government. On the other hand, Resource Dependence chronicles the ways firms will struggle against such regulations and interdependencies; in the US this is often done by the largest firms, and through industry associations. In many ways the environmental history of the late 20^{th} and early 21^{st} centuries has been a chronicle of the struggle of industry against increased pro-sustainability regulations and potential resulting interdependencies. Resource Dependence therefore illustrates the complex nature of firm behavior, and how it is influenced by social and political context.

We can see that Resource Dependency helps explain much of the activity and churn going on in the treadmill, thereby illustrating parts of TP. What does Resource Dependence have to tell us about EM?

Resource Dependence and EM

EM sees public demand as intrinsic toward a sustainable shift, and predicts that people will come to expect firms to base decisions on environmental considerations (Fisher and Freudenberg 2001; Mol and Spaargaren 2004; Shwom 2011). For example, EM predicts that people will create new and expand old environmental nongovernmental organizations (NGOs) that will put increasing pressure on companies to behave in environmentally appropriate ways; will pressure governments to implement old and create new environmental regulation; and will base their consumption on environmental concerns. EM predicts that companies will respond to this pressure by altering decision making processes from those based solely on resource considerations to those that take into account environmental concerns, and governments will tighten regulations appropriately (Shwom 2011). EM also recognizes that as technology develops, it tends to become more efficient and produces fewer emissions. Central to the EM thesis is that new equipment will eventually eclipse the messier, less efficient old machines and lead to better environmental results (Fisher and Freudenberg 2001).

Finally, EM maintains that employees themselves will contribute toward the desired changes in organizational behavior. Younger people tend to have a natural interest in more sustainable production, and as they join firms and eventually rise to leadership roles, they will choose different paths of industrial development (Farrow, Johnson and Larson 2000; Shwom 2011). In fact, this phenomenon has been observed in modern plastics firms (Esposito 2020).

Basically, the EM argument is that the development of sustainability, including the internalization of environmental impacts, is an inherent part of modernization (York and Rosa 2003a). Firms will respond to the consistent and strong pressure of stakeholders with the appropriate changes to equipment and protocols, and the human world will be saved. EM does not argue with TP's prognosis that current industrial activity is hazardous, but it does advocate a view of human beings as essentially rational in extremely self-regulated ways: that current economically-based behavior can be voluntarily altered through developing awareness of distal environmental hazard. In other words, we can install a control panel on the treadmill.

Looking at these propositions through the lens of Resource Dependence brings doubt to these conclusions. Based on the analysis of Resource Dependence, firms would be predicted to avoid sustainability practices that will require substantial investment of funds or company time unless it is required by enforced law or all other firms in the field engage in the practice, and so it becomes a best practice or legitimacy requirement. This is because firms must survive and thrive, and in the competitive environment that most firms find themselves in, decreasing margins by making investments that do not result in a material economic benefit to the firm would be putting the firm at competitive disadvantage.

Competitive markets provide a kind of singular economic focus and discipline to life in for-profit firms. Large outlays of funding for projects that will not improve the financial bottom line can be seen as a kind of financial malfeasance by shareholders and owners, and managers based on fiduciary duties. In fact, the few studies existing of company internal decision making on sustainability investments bears this out. For example, Collins et al. (2006) study of New Zealand businesses and sustainability practice found that a majority of all firms studied cited cost as a primary inhibiting factor of taking up sustainability measures. Wiesner et al. (2018) found that environmental champions in small and medium sized businesses needed to make the economic case for environmental sustainability to the staff, not just managers and owners, and that these firms often did not have the resources for far-reaching sustainable change. Bos-Brouwers (2009) found that sustainable changes adopted primarily brought about efficiencies to production and cost savings.

EM also makes predictions about the public that are difficult to square with observed tendencies, undercutting claims about the potential for legitimacy gains through sustainability. It has been shown that most consumers will choose a preferred, or even less expensive, item over an environmentally compliant item that costs more (Bask et al. 2013; Hart and Dowell 2011; Rahman, Stumpf and Reynolds 2014). Similarly, Rahman et al. (2014) found that even consumers who identified as "ecocentric" preferred wine based on taste rather than sustainable sourcing. It has also been demonstrated that even educated consumers of corporate information do not read the sustainability reports of firms they are interested in (Peloza et al. 2012). In fact, Peloza et al. (2012) found that when making large purchases, consumers specifically avoid knowledge of firm environmental compliance. Collins et al. (2006) found that most New Zealand firms did not feel pressure from customers regarding sustainability, but instead larger firms felt pressure from stockholders and employees. Although the need for sustainable action appears obvious to many, there is not much evidence that consumers will rise and demand environmental compliance with the strength of purpose that will change firm behavior in the aggregate, although we can hope for such a transformation, and work for it (Rudel et al. 2011).

What Resource Dependence tells us about EM is that unless environmental action can be associated strongly with the resources firms need to survive, it is unlikely that firms will make the kind of behavioral changes that lead to real environmental progress. Many of EM's points rest on the assumption that the public strongly supports sustainability, which in a democracy would cause the government to create sustainability requirements and enforce them. One would also predict increases in the numbers of pro-sustainability legitimacy requirements where the general public is environmentally conscious as well. As discussed before, Resource Dependence predicts that under these conditions, firms will be, by and large sustainable. There is a great deal of evidence covered in this section, however, that indicates that despite public interest in sustainability, the will has not yet been developed to create meaningful environmental regulation, or enforcement. Firms are likely, therefore continue to fight what is seen as the imposition of new interdependencies.

Institutionalism and Neo-Institutionalism

Institutionalism and Neo-Institutionalism are related schools of thought that can be somewhat confusing, however it is worthwhile to understand them when thinking about manufacturing. Institutionalism is the older form of meso thought.

Institutionalists are interested in the symbolic and material organization of society through self-reproducing meaning systems that may emerge through regimes (a central authority system), culture, or formal organizations (Jepperson 1991). These meaning systems are variously defined, for example education is often noted as an institution, as well as the military, religion, and politics. Insofar as we can call education an institution which attends to the teaching of knowledge for example, it is likely that we can call manufacturing an institution which attends to the creation of products and includes its own history, traditions, and ways of thought about a process just as important as education to modern life. Manufacturing has its organization of roles (facility owners, managers, engineers, salespeople, line workers, etc.); reproduction processes (colleges and universities, industry association conferences and coursework, in-facility training); information about itself (manuals, best practices -often stewarded by industry associations-trade journals, and STEM publications); resource networks (customers, vendors and banks); and local functionaries who practice manufacturing in innumerably different ways (companies). [8]

Neo-Institutionalism emerged from Institutionalism over recent decades as a two-part theory describing organizational behavior and field dynamics. Neo-Institutionalism is associated with two seminal articles, the first by John Meyer and Brian Rowan (1977), "Institutionalized Organizations: Formal Structure as Myth and Ceremony" and the second by Paul DiMaggio and Walter Powell (1983), "The Iron Cage Revisited: Institutional Isomorphism and Collective Rationality." Both lines of thought argue that the legitimacy, or the ability of a firm to comply with societal expectations, is the most important factor of survival. For Meyer and Rowan (1977) firms will attempt to comply with requirements from governments, competitors, and publics, however, in cases where such cooperation may impinge on the firm operating process, the firm may offer only symbolic compliance through a process called "loose coupling." Loose coupling refers to unseen and inexact connections between public-facing departments and pronouncements and the production processes. This is particularly cogent with regard to environmental concerns, where the public relations team and lawyers may be easily available in major metropolitan centers, but operations may be distal (out of state, in rural areas, or overseas) and not only "loosely coupled," difficult to measure or discover. In the area of sustainability, what Meyer and Rowan describe may also be called "green washing."

DiMaggio and Powell (1983) also describe the importance of legitimacy, however in this case, they focus on methods of acquiring legitimacy and how these change the organization. Firms are influenced at three levels (coercive, often government regulation; mimetic, often competing firms, and normative, often the ideas brought into the firm by employees through

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[8] Because plastics deals with a specific type of material (polymers) with a set of interrelated production processes and understandings, and a rather large set of subfields, I will discuss it as a field within the institution of manufacturing in this work.

education and training) which often work to make firms more like each other in a process called organizational isomorphism. This similarity brings legitimacy as firms are seen to be engaging in best practices, meeting industry standards, and serving consumers in familiar ways.

What can Neo-Institutionalism tell us about TP and EM?

Neo-Institutionalism, EM, and TP

EM has been characterized as essentially an institutional theory (Shwom 2009; Mol and Spaargaren 2005) which argues that as society comes to accept the importance of sustainability, people, firms, and governments will alter their behavior, changing the function of the economy in key ways. EM proposes that market-based solutions will incentivize firms to adopt more efficient technology, dispose of wastes appropriately, and make other sustainable decisions (York and Rosa 2003b). Unlike TP, EM does not promise a world healed of inequality and suffering, nor does it promise that all environmental concerns will be remediated, only that people, and their social systems, will find a way to survive.

Although, as previously noted, EM has been characterized as institutional in nature, it also assumes an agenda, that manufacturing will gradually become more sustainable. Sociological institutional theories, however, do not make directional assumptions. They simply attempt to explain organizational behavior. For example, the isomorphic process, described by DiMaggio & Powell (1983) does not predict specifics of organizational change, only that organizations will tend to become more alike. Certainly, one could see the process of isomorphism leading to increased sustainability provided that publics and governments demanded it such that coercive, normative, and mimetic forces pushed in this direction. In fact, there has been normative pushes toward sustainability through the formal education of new plastics employees in STEM programs (because University scientists tend to recognize the importance of sustainability) as well as through industry association programming. The demand of younger employees for more sustainable organizations has been widely reported on in plastics trade publications. One could argue as well that there have been some mimetic pushes toward sustainability through firms occasionally attempting to compete by advertising increased sustainable packaging, processes, or corporate giving. For example, in 2018 Coca-Cola promised to use at least 50% recycled material in product packaging by 2030, and 100% by 2025. These movements toward sustainability in plastics have not been followed up with coercive action, however as Obama-era attempts to tighten environmental regulation have been largely dismantled by the Trump administration, and in any case, it is arguable whether any US administration has had the will or the resources to implement the laws on the books effectively, perhaps since Carter. In other words, without strong enough public demand to lead to definite coercive action, isomorphic processes may or may not lead to increased sustainability. Organizational isomorphism could just as easily lead to movement toward increased fossil fuel dependence, and, in fact may have in some cases based on the alternate vision of climate change presented by Exxon Mobile and the American Petroleum Institute (Oreskes & Conway 2011).

Similarly, Meyer & Rowan (1977) explain how companies will avoid costly entanglements and demands from stakeholders through ceremonial compliance, which allows the firm to engage in legitimacy seeking behavior without changing production processes. Again, plastics firms may currently be engaging in ceremonial compliance with public interests in sustainability when they claim to be engaging in sustainable practices, or when they request that industry associations add pro-sustainability pronouncements to their websites.

DiMaggio & Powell (1983) can therefore support the EM view of sustainability under the conditions of a public that demands sustainability and a government ready to create and enforce laws supporting sustainability. On the other hand, Meyer & Rowan probably support the TP view of sustainability. On the other hand, Meyer & Rowan (1977) argue that firms will always avoid outside demands to alter their production processes through loose coupling, and therefore likely do not support the EM view.[9] Examples of noncompliance are widely available, however one can understand the regularized nature of this by considering Hoffman, who only investigates company communications, not environmental outcomes, which are after all, difficult to obtain. Firms are not required to measure waste creation, and often do not (Wiesner et al. 2018). Even the self-reports of toxic chemical waste in the TRI are often estimations of waste based on the amount of the production run, called "mass balance calculations" (EPA TRI Program 2017). Actual measures of emissions are hard to come by, which means that at this time, we simply cannot be sure how much of firm adoption of pro-sustainability operations is ceremonial.

Whereas Neo-Institutionalism does not purport to predict the future as both TP and EM do, Neo-Institutionalism, like Resource Dependence, can explain many systemic reasons why firms may not respond in either the TP- or EM-predicted way. Neo-Institutionalism predicts that firms will adopt changes such that companies across any particular field will come to resemble each other, but it does not attempt to predict which changes will be adopted, what direction an industry will pursue in the future, and importantly, Neo-Institutionalism predicts that a great deal of the change will be ceremonially complied with. EM assigns a value to sustainability, however, predicting that as people become more and more concerned with global climate change, this will drive firms to become more concerned and create real sustainable change. If EM was somewhat more Neo-Institutional, however, an EM theorist might need to address the problem of how the direction of organizational change can reliably be predicted.

As this is being written (Summer 2020), the public has primarily become concerned with COVID-19 and so firm websites are engaged in public declarations of solidarity with the ill,

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[9] Meyer & Rowan's critique is an important one, and they are one of the few organizational theorists, aside from Vaughan, that account for organizational malfeasance.

safety for employees and customers, and how firm operations will be managed in regard to this new contagion. Sustainability appears to have been supplanted in effect, and Neo-Institutionalism would caution us not to assume that it will automatically be taken up again once COVID has been effectively managed. Public and government concern, translated into future legitimacy requirements, cannot be predicted, only that firms will engage in a specific series of activities designed to allow them to run with the least interference possible.

Conclusion

This has been an exercise in evaluating whether meso-level theories, Resource Dependence and Neo-Institutionalism, provide evidence to support the TP and EM macro-level views of resource management and how humankind will fare under Global Climate Change. We find that both Resource Dependence best supports the TP view, and this is likely not surprising as TP has been developed on the basis of Marxist thought, which presents a compelling view of the behavior of firms and nature of capitalist production. EM adopts some aspects of the Institutional view, however without the analytical vigor to take into consideration the risks that Neo-Institutionalism points out, i.e., that firms, when presented with legitimacy demands to change behavior, will respond differently based on the relative coercive or competitive origin of the demand. External demands may be responded to, but not necessarily complied with.

Environmentalism, sustainability, and most of all, climate change, form scientific work with the logical conclusion that other institutions must change in large, noticeable, and expensive ways. Entire systems of energy production, like coal or petroleum, and the firms that operate them, must step back from operation. Entire aspects of the economy must be rethought, for example, transportation, packaging, and logistics. The way consumers travel to work, how we throw things away, and what kinds of light bulbs we use becomes controversial. Because institutions do not act (Jepperson 1991), of course, but are sets of interrelated behaviors and roles that people engage in, the question of whether the recommendations of science will be complied with becomes a matter of public controversy in which new and retooled activist organizational actors are formed or adapted to take up the argument of one side or the other (Meyer and Bromley 2013). The question of sustainability has been controversial for decades and will continue to be until a consensus is reached on whether to act toward a cleaner planet, or not.

In fact, the concept of sustainability, because it is a point of contention, makes an excellent lens through which to observe organizations. Sustainability is a broad concept that has not been fully legitimated. From messages promulgated on industry association websites to membership in industry associations, to toxic chemical emissions, firms make choices about how sustainability is displayed and how it is to be practiced. The fragmented nature of sustainability allows observation on how organizations voluntarily respond to this unimplemented but popular demand. A question asked in this work is whether sustainability might be a legitimacy point that differentiates a successful firm from others, by asking whether larger, wealthier firms may be more sustainable and firms lacking in resources may be less.

This chapter has introduced several theoretical frameworks that hopefully have caused the reader to rethink assumptions about sustainability and how it is practiced by manufacturing in general and US plastics firms in particular. Sustainability is complex and has multiple meanings and implications even for people who are dedicated to it. In the next two chapters, the real-world implications of sustainability will be examined through the analysis of emissions data from US plastics firms (Chapter 3) and their industry associations (Chapter 4). Questions examined include what plastics firm characteristics are more or less likely to lead to higher emissions and whether the structure of plastics firms has anything to do with sustainability. Issues of industry associations and sustainability will be examined in Chapter 4.

Chapter 3, Toxic Emissions in the Plastics Industry

1. Introduction

When thinking about the characteristics of a facility that might affect emissions, size, resources, and structure are three likely candidates. Size is certainly an obvious variable to consider. This is partly for the obvious reason that larger facilities will be expected to create more emissions, simply because they produce more products, but also because larger firms tend to have more resources, and smaller and medium firms tend to have fewer resources (Wiesner, Chadee and Best 2018; Bos-Brouwers 2009; Holt, Anthony and Viney 2000). Resources are important, of course, because it takes funds to buy new equipment, research and design new production process, and hire new employees. Organizations with more resources may be in a better position to pursue sustainability on a voluntary basis. Finally, firm structure may also affect sustainability practices, based on previous work demonstrating that firms with more subsidiary layers tend to release more toxic emissions (Prechel and Zheng 2012), and that large chemical facilities (sister organizations to plastics facilities) embedded in corporations also tend to emit more (Grant, Jones & Bergesen 2002).

This chapter explores whether these simple characteristics of plastics firms, size (of facility and firm), resources, and structure, affect pollution releases by regressing normative, or Planned Toxic Emissions and Fugitive Toxic Emissions (derived from the Toxics Release Inventory, or TRI) on plastic firm Credit Rating, Revenue, number of Facility Employees, and number of Subsidiary Layers, variables derived from Duns & Bradstreet Hoovers (D&B Hoovers 2020) financial data in a series of multilevel regressions. The structure of the data, emissions data on facilities from the TRI and financial data on firms from Hoovers imply a two-level structure suitable for multilevel regression with facilities as level 1 and firms as level 2.

Toxic emissions vary across products, facilities, and firms, and this chapter will present hypotheses to explain and test this variation, offering information about the nature of 1,777 US plastics facilities and 1,036 plastics firms that reported toxic releases to the EPA in 2016.[10] In performing this analysis, it is assumed that the toxic emissions of the plastics industry are not simply a byproduct of industrial processes, but can be used as an indicator of these processes. In fact, given the dearth of independent source information on the actual creation of goods across firm type (public vs. private), the analysis of toxic emissions data may be one of the most useful means available to independently explore aspects of US industrial production.

While there have been many very good studies of facility-level toxic data, this study is unique in several ways. First, it is based on one industrial sector, plastics, whereas many similar studies using TRI data examine firms across industrial sectors, in spite of difficulties of comparability (Gerde and Logsdon 2001), see for example, Harrington, Deltas and Khanna 2014; Vidovic and Khanna 2007; and Prechel and Zheng 2012. This work appears to be the first such study on toxic emissions in the plastics industry. New variables are also introduced through this work, for example the use of Fugitive Emissions as a dependent variable; Risky Firm Credit, a measure of a company's overall financial health and Public, a dummy variable representing publicly traded (as opposed to privately held) firms.

Finally, because this study looks deeply into the plastics data, rather than widely across industrial sectors, it includes firms of a very wide variety of sizes and types, from small businesses with one facility up to large corporations with hundreds of facilities. Many similar

[10] All facilities analyzed in this study are located in the continental United States.

studies exclusively rely on the data of large public firms through the Compustat database (Wharton Research Data Services 2020), which features Securities and Exchange Commission (SEC) filings. Using only public firm data would cause this study to employ only a fraction of the actual numbers of firms operating in plastics for 2016, as demonstrated by Table 1, which refers to the current sample. We can see here that public firms are not only a fraction of the total number of plastics firms in this dataset, but they also tend to be over-represented among larger firms, while private firms make up the vast majority of small firms (under 17 facilities or subsidiaries). Obviously private firms are an important component of the plastics industry and should be included in analyses where possible.

Table 3.1, Plastics Firm Governance and Size, Current Sample

	Private	Public	Total
Single Facility Firm	445	1	446
2-17 Facilities or Subsidiaries	313	11	324
18+ Facilities or Subsidiaries	106	160	266
	864	172	1,036

This chapter will introduce the concepts of Planned and Fugitive toxic emissions, and then introduce the variables of interest, Risky Firm Credit, Facility Employees, Revenue, and Subsidiary Levels. The significance of using a new data source, D&B Hoovers, will be discussed, including the benefits of including a more various sample of firms for analysis. Finally, after the controls are discussed, the analysis is performed and results are presented where it is found that firm size and resources, subsidiary layers, and facility size have significant effects on Planned Emissions.

2. Data and Sample

The Dun & Bradstreet Hoovers (D&B Hoovers 2020) database provides a variety of variables on the characteristics of both public and private firms in the US. Dun & Bradstreet holds records on approximately 120 million firms, gathered as part of their credit rating operations (Dun & Bradstreet), and Hoovers sells this data primarily as sales leads. Financial data are reported voluntarily by firms to Dun & Bradstreet.

Use of Hoovers presents both opportunities and liabilities in terms of the data offered. The main opportunity is the ability to access data on a far wider range of firms than that presented by Security and Exchange Commission (SEC) filings, which is often used in studies linking the toxic emissions of firms to financial characteristics. SEC filings yield data only on large public firms, which represented only about 3,671 of all firms in the US in 2017 (Thomas 2017), or about 1.5%. Because of D&B Hoovers, the present analysis presents a relatively wider view of plastics as it includes 863 private and 173 public plastics firms.

On the other hand, use of Hoovers data present some limitations. For example, there are fewer data fields available for analysis, specifically, because Hoovers data are based on Dun & Bradstreet collections, it roughly maps on to what a credit analysis service desires in data and what the company feels it can sell through Hoovers. Another limitation is that Hoovers does not make past years available for easy download, as is available through the WORD database (which makes many years of SEC data available to researchers).

The dependent variables come from the Toxics Release Inventory (TRI), a dataset created and maintained by the US Environmental Protection Agency (EPA) and established by Congress through the Emergency Planning and Community Right-to-Know Act (EPCRA) in 1986 (U.S. Environmental Protection Agency). Data in the TRI are reported by facility, with information on parent company, location, and releases of toxic chemicals by method of release: air, water, landfill, or to contractors for disposal, etc. Firms from 411 industrial categories (NAICS codes) and federal facilities are required to report if they have more than 10 full-time (or equivalent) employees, and store or employ one of the 593 reportable toxic chemicals at the designated minimal level (U.S. Environmental Protection Agency). Reportable chemicals include for example, dioxins, as well as ammonias, lead, and some greenhouse gases, including methane.

The TRI is based on reports filed by facilities per toxic chemical. For example, in 2016, Dura Coat Products of Riverside, California emitted (among other chemicals) a total of 52,000 pounds of n-butyl alcohol (a solvent), 70,000 pounds of naphthalene (a wetting agent), and 82,000 pounds of xylene, which in some forms is a solvent, and in others is a precursor to polyethylene terephthalate (PET) which is used to make plastic bottles among other products. Each of these emissions represents a report and is assigned a document control number. Each report is associated with a facility (level 1 in the data), in this case, Dura Coat on 5361 Via Ricardo in the Belltown area of Riverside near Market Street and Rubidoux Avenue. Dura Coat Riverside is one of two manufacturing facilities; the other is in Madison, Alabama (part of the Huntsville Metropolitan Area). Dura Coat as a firm (level 2 in the data) manufactures various coatings for metal products, for example, architectural coatings that protect metal roofing. In 2016 Dura Coat was acquired by Axalta Performance and Transportation Coatings, a publicly traded firm.

Chemical reports to the TRI are sometimes made more than once in a year. This occurs often when a correction needs to be made to the prior report (EPA 2019). In the cases of multiple reports in the dataset, the latest report of the year was retained. Where multiple reports occurred on the same day for different amounts, one report was selected at random and retained. This occurred 15 times, or with .002% of the data.

Sample

The firms studied include all U.S. plastics firms that reported data to the TRI and for which data were available in Hoovers in 2016. Plastics firms are indicated by primary NAICS number as either 326100-326199 (resin producers) or in one of several other primarily plastics manufacturing areas, for example, 325220 Artificial and Synthetic Fibers and Filaments Manufacturing or 326113 Unlaminated Plastics Film and Sheet (except Packaging) Manufacturing (Please see Table 3.4, below for a complete listing of the NAICS codes represented in this sample). There are a total of about 1,868 plastics facilities and 1,318 plastics

Table 3.2, NAICS Codes Included in the Study

NAICS Code	Industry Description	Number of Facilities*	Percent of Total
325211	Plastics Material and Resin Manufacturing	335	18.85%
325212	Synthetic Rubber Manufacturing	36	2.03%
325220	Artificial and Synthetic Fibers and Filaments Manufacturing	18	1.01%
325510	Paint and Coating Manufacturing	358	20.14%
325991	Custom Compounding of Purchased Resins	166	9.34%
326111	Plastic Bag and Pouch Manufacturing	1	0.01%
326113	Unlaminated Plastics Film and Sheet (except Packaging) Manufacturing	65	3.65%
326121	Unlaminated Plastics Profile Shape Manufacturing	25	1.40%
326122	Plastics Pipe and Pipe Fitting Manufacturing	41	2.31%
326130	Laminated Plastics Plate, Sheet (except Packaging), and Shape Manufacturing	52	2.93%
326140	Polystyrene Foam Product Manufacturing	15	0.84%
326150	Urethane and Other Foam Product (except Polystyrene) Manufacturing	198	11.14%
326160	Plastics Bottle Manufacturing	3	0.02%
326191	Plastics Plumbing Fixture Manufacturing	78	4.40%
326199	All Other Plastics Product Manufacturing	386	21.72%
	Total Facilities	**1,777**	**100%**

**Because several firms have facilities with multiple NAICS codes, firms cannot be given per NAICS.*

firms listed in the TRI for 2016 (author's figures), out of a total of 10,044 U.S. plastics firms listed by the US Census (2015); so the TRI includes about 19% of all US plastics firms.[11] Then, because of incomplete records and missing data, this sample was winnowed down to 1,777 facilities for level 1, and 1,036 firms for level 2.

While this study is not, therefore, statistically representative in the classic sense, it does contain firms of a much wider variety of sizes and governance types than previous studies have and this makes it likely more representative than previous studies have been. This variability makes the sample sound for hypothesis testing, even if there may be uncertainty about the generalizability of the resulting analysis.

3. Hypotheses and Variables

Dependent Variables: Toxic Emissions, Planned and Fugitive

The creation and processing of all types of plastics tends to produce toxic chemical releases (Patel and Xanthos 2001). The EPA requires reporting on 595 of these chemicals which potentially cause long term human health problems (like cancer), dangerous short term health problems (like difficulty breathing or blindness), or large negative effects on the environment, (like fish kills) (US EPA, OSWER, Office of Emergency Management 2012).[12] The Plastics and Rubber sector produced 5% of all toxic chemical emissions to air in 2017, as estimated by the EPA (EPA TRI Program 2017). Releases are defined as any escape of toxic chemicals from a facility, whether as planned releases of fumes to air, as effluence to waterways, or as solid wastes

[11] Not all plastics firms report to the TRI. Firms from 411 industrial categories (NAICS codes) and federal facilities are required to report if they have more than 10 full-time (or equivalent) employees, and store or employ one of the 593 reportable toxic chemicals at the designated minimal level (U.S. Environmental Protection Agency).
[12] It should be noted that this list, although updated from time to time, does not include all possible toxic chemicals in use in the US at any particular time (EPA Office of Compliance 2005).

to the earth (for example, landfills). Planned releases also include wastes released to brokers, recyclers, or other waste management professionals.

One division of emissions to air is between point source emissions and fugitive emissions. Point source emissions are releases to air through vessels designed to conduct the gaseous results of production from the facility to the environment, such as chimneys, stacks, or pipes. The firm may also expect other types of wastes as part of the production process in addition to emissions to air, including slurries, solid wastes, waste liquids, etc. and so will have established means to convey these wastes away from the work area and to disposal, transportation, storage, etc. In this dissertation we will call "Planned Emissions" all of the wastes that a firm expects to emit, and so has established normative processes to treat and/or convey these away from the immediate workspace.

Fugitive emissions, on the other hand, are defined by EPA as "…those emissions which could not reasonably pass through a stack, chimney, vent, or other functionally-equivalent opening" (Code of Federal Regulations 1992), and so are unplanned. For the plastics industry, fugitive air emissions can include leakage, evaporation from spills or containment structures, or accidents (EPA Office of Compliance 2005), for example, equipment malfunction, leading to a fire that burns some amount of the production materials. On a larger scale, the recent flooding of the Houston area in August of 2017, a major region for plastics production, led to explosions of toxic chemicals at an Arkema plant which released and spread harmful chemicals throughout the radius of the area (Weill and Paulsen 2017) as well as the release of toxic substances into the flood waters. Fugitive Emissions are estimated in a variety of ways, including mass balance calculations, local published data, and various types of onsite monitoring. Fugitive Emissions comprises the other dependent variable for this study.

Release of toxic chemicals has been used as the dependent variable for many studies over the years and are often pooled, or added together to get one estimate of poundage that represents all of the chemicals combined (See for example, Harrington et al. 2014, Prechel and Zheng 2012, Grant, Jones and Trautner 2004, and Dooley and Fryxell 1999). This study also pools all Planned Emissions together into one dependent variable and all Fugitive Emissions together into another dependent variable. Facilities provide the basis for emissions calculations in the TRI, including mass balance calculations (or the estimation of emissions based on inputs and production activity); published emission factors; on site-specific emission factors; or various types of monitoring data (EPA TRI Program 2017). This means that with the exception of those firms that can afford sophisticated monitoring equipment, much of the emissions data are estimated. Further, emissions vary over time based on ambient conditions, differences in source materials, repair and condition of the equipment, and other variables (Frey and Small 2003).

Both Planned and Fugitive Emissions are available through the TRI and are expressed in thousands of pounds per chemical per year. For the purposes of this project, all of the chemicals produced by a facility are combined into one measurement, a process called "pooling." While dioxins are given in ounces in the TRI, these were converted to pounds as preparation of these variables. Due to high skew, these variables are converted to natural logs before use in the analysis. As a result of this transformation, relationships in later models express effects of differences in independent variables on proportional (rather than raw) emissions.

Variable of Interest: Risky Firm Credit

Organizations that are resource-poor or highly leveraged tend to receive less favorable credit ratings (Langohr and Langohr 2008); *ipso facto*, organizations with less favorable credit ratings may be less able to attract capital. Problems with credit may cause the consolidation of internal funding flows toward core organizational survival processes, and away from processes that do not immediately increase operational revenues, such as sustainability measures like emissions reduction. This diminished liquidity may cause decreased access to funds for expansion, a lower likelihood of using the latest emissions-reducing equipment, and make the firm less likely to have the additional employee labor and programs that might be dedicated to diminishing emissions or increasing safety.

How credit risk is analyzed and labeled is a trade secret for each credit ratings agency (Langohr and Langohr 2008), so exactly what this measurement indicates is not available to this project. What is known is that a great deal of credit risk evaluation is based on cash flow and resources on hand, as well as current leverage and past history of attending to debt. This generalized rating is made by experts who consider a wide variety of characteristics of the firm, including firm and industry history, current market conditions, firm leverage and liquidity, etc. (Langohr and Langohr 2008). This variable is therefore used as a proxy for diminished access to resources by facilities and makes possible the first hypothesis.

H1: The facilities of high credit risk firms will produce more toxic emissions.

Risky Firm Credit is a dummy variable with a value of 1 when the firm has a medium or high credit risk rating, and 0 otherwise. Medium and High Credit Risk were combined in order to highlight the concept of "bad credit" (1), and in order to assist in the perception of the effects of the variable. Risky Firm Credit is a level 2 variable derived from D&B Hoovers (D&B Hoovers 2020).

Facility and Firm Size

The distinction of size has been an important factor in assessing firm emissions. This is partly for the obvious reason that larger facilities and firms will be expected to create more emissions, simply because they produce more products. While larger firms would be expected to emit more, they also likely have more resources to commit to safety and emissions reduction, while smaller and medium firms are expected to have fewer resources (Bos-Brouwers 2009; Wiesner, Chadee and Best 2018; Holt, Anthony and Viney 2000). Some larger firms also experience more pressure from the public to emit less when they are highly visible brands (Bartley and Child 2014; Dauvergne and Lister 2012). This is important as the introduction of environmentally-helpful equipment and practices often require an initial investment of labor, expertise, and funding, so even when sustainability initiatives may save the firm money over time, the initial investment may be out of reach for small and medium firms (Bos-Brouwers 2009; Holt et al. 2000; Wiesner et al. 2018). In a related sustainability area, green purchasing, although small manufacturing firms (less than 500 employees) have been shown to consider green purchasing important, they are less likely to engage in it due to cost considerations (Galle and Min 2001).

One of the highlights of working with the Hoovers data is the opportunity to compare the emissions performance of small and large firms, however how to measure size effectively emerged as an issue to consider. The number of employees by firm variable in Hoovers was difficult to estimate in 2016 because the variable did not appear consistent. At times it appeared that the number of employees for the entire firm was offered, and at others only the employee count for the immediate office appeared to be available. Although this might be related to firm structure as an example of the Multi-Subsidiary Form, there was no obvious way to ascertain whether this was true, or whether the firm-level employee count was incorrect. Instead, Firm Revenue is employed as the measure of firm size.

Use of revenue somewhat changes the understanding of firm size, as Firm Revenue implies wealth as well as size, but perhaps this is a useful distinction because arguments about the capacity to adopt sustainability measures (per above) revolve around access to capital rather than number of employees. It is also important to emphasize that Firm Revenue is a level 2 variable, indicating organization size, not facility size, which will be examined separately. It is entirely possible to have a very large firm with a small facility, and to some extent, vice versa. For the sake of the necessity to set a hypothesis, then, we will predict that large firms produce more emissions, but will also introduce an interaction with an organizational structure variable later to further examine the complexity of this assertion.

H2: Larger firms will produce more emissions.

Revenue (level 2): This variable is provided by Hoovers and is the firm self-report of how much revenue was received during the last year. Due to extreme skew, Revenue is logged (see Table 3.3).

Facility size has often been measured by sociologists by number of employees. A number of developments in modern manufacturing call this practice into question, however. First, plastics firms often use continuous process production techniques carried out in many facilities with the assistance of artificial intelligence (AI) and robotics. Such facilities will naturally employ fewer workers, and indeed, walking through such a facility gives the impression of great emptiness in spite of obvious activity as there is often just one employee per very large robotic machine that does the actual production. Although this area has not been much explored in the literature, Galle and Min (2001) found that although larger firms (as measured by purchasing power) are more likely to adopt sustainability procedures, the number of employees had no effect on the analysis. Of course, it can be assumed that facilities vary in terms of technology, with poorer firms having fewer AI-driven solutions, and therefore potentially a larger number of employees, and more successful firms using more advanced equipment that requires fewer workers (Choudhary et al. 2019). The question therefore, is not so much whether number of facility employees corresponds with greater production of emissions, but whether larger numbers of facility employees may be associated with higher emissions to a certain point where the wealth of a firm may indicate adoption of more sustainability technologies and programs, leveling emissions out, or even driving them down. To test this idea, Facility Employees will be tested for nonlinear effects, leading to Hypothesis 3.

H3: The more facility employees, the higher emissions to a specific tipping point where presumably the adoption of sustainability technologies and programs will start to drive emissions down.

Facility Employees (level 1): This is the number of employees working in each facility as provided by Hoovers. Facility employees is a continuous variable transformed by the natural log due to extreme skewness (see Table 3.3).

Firm Peakedness

Peaked firms can be thought of as those with many subsidiary levels between a facility and the ultimate parent firm. Recently, Prechel and Zhang identified the emergence of the Multi-layer Subsidiary Form, which is essentially a corporation that organizes its “divisions” as majority-owned subsidiaries. This arrangement allows the corporation to draw profits from the subsidiary as dividends and reduces corporate responsibility for pollution mitigation and for environmental liability because the corporation and subsidiary are legally independent of each other (Prechel and Zheng 2012). Such an arrangement has obvious attractions where the parent firm can harvest profits without the responsibility for the costs of maintaining subsidiary infrastructure nor bear the legal responsibility in cases of environmental accident or malfeasance. In addition, aside from the potential of engaging in the Multi-Subsidiary Form, it may be likely that firms with many layers of organization may present coordination issues. Certainly, it is interesting that the largest firms in this sample have a high of 7 subsidiary layers, while the largest number of layers for any firm in this sample is 12.

It was not possible to identify firms practicing the Multi-Layer Subsidiary Form in this sample, however, the number of subsidiary layers could be counted, as Prechel and Zheng did. This leads to Hypothesis Four, which predicts that peaked firms with a larger number of levels between the topmost parent firm and the facility, will release more toxic emissions.

H4: Peaked firms will release more toxic emissions.

Firm Layers is an ordinal variable that was derived using data from D&B Hoovers by recording each layer of ownership for each facility. Firm Layers ranges from one for single level firms to 12, primarily for a few large corporations, with a mean of almost three layers (2.79) and a standard deviation of almost two layers (1.80). As can be seen from Table 2, the majority of firms in this study are single level companies, where the firm and the company are the same entity. The next largest number are those firms that consist of one or more facilities and a management entity. Firms with three levels come next, and so on. It is assumed that those firms with four and more levels may be multi-subsidiary forms, however this was not confirmed during data collection.

Table 3.3, Mean Revenue by Subsidiary Level for Plastics Firms, Current Sample

# Subsidiary Levels	Mean Revenue	SD	Count
1	26M	87M	564
2	4.6 B	23B	285
3	11.2B	33.8B	183
4	14.6B	32.9B	109
5	17.6B	23.9B	39
6	15.7B	19.5B	11
7	18.2B	20.9 B	8
8	6.7B	8.9B	3
9	21B	27.2B	3
10	22.2B	28.9B	2
11	22B	19B	3
12	5.2B		1

Because the majority of plastics firms in this sample are very small, it is likely that Firm Layers may be related in this instance to the size of the company, which invites an interaction check for Firm Layers and firm size, in this case, Revenue. It is possible that the large firm propensity to emit larger amounts of toxic waste may be affected by how many subsidiary layers have been set up between the topmost operating firm and the production facilities, as proposed by Prechel and Zheng (2012), leading to the fifth hypothesis.

H5: Large firms with more levels will release more toxic emissions.

Controls

Public (Hoovers) is a level 2 categorical variable with two possible values: (1) publicly owned, meaning that shares of at least one subsidiary layer of the firm are traded on public markets or (0), private, which indicates that the firm is owned privately, has limited access to public finance, and privacy in terms of internal affairs. Because many of the firms are made up of subsidiaries, and because public firms can own private subsidiaries, and private firms can own a controlling interest in public firms, firms are defined as public if there is one public subsidiary at some level of the firm, usually the top level. In this dataset, 16.6% of firms are public, and as can be seen from Table 3.1, most public firms are large, and most private firms are small.

Small Business (level 3): This is a level 2 dummy variable recording whether a firm is a small business of 2 or fewer facilities and organizational levels (facility and firm). Firms of 1 or 2 facilities are by far the majority of firms in this sample and include 953 firms. Small Business is included in addition to Revenue as a measure of size because it is assumed that genuinely small businesses have very different operating realities from other firms and this should be controlled for. Because Small Business is measured differently from Revenue, on the basis of number of organizational levels and facilities, these variables are different enough to include in the same analysis.

North American Industry Classification System (NAICS) Code: The NAICS code is a level 1 categorical variable that represents the classification system established by the Office of Management and Budget that categorizes firms based on business product (Executive Office of the President and Office of Management and Budget 2017). Fifteen NAICS codes were selected with reference to the EPA definition of plastics manufacturers (EPA Office of Compliance 2005) and form the basis of this sample. NAICS code is used as a control for technical variability between firms, as it is assumed that different technology used to produce specific products (for example, plumbing pipes versus latex paint) will result not only in differences between chemical components involved in production, but also mitigation technologies available to be adopted (see Table 4). NAICS code comes from the TRI dataset, and while facilities may have several NAICS codes, this study uses only facilities with a plastics-based primary NAICS code.

Table 3.4, Summary Statistics

	N	Mean	SD	Min	Max	Skewness
Planned Emp.(L1)	1,777[1]	9.145	33.404	0	545.123	8.158
Fugitive Emp. (L1)	1,777[1]	3.266	19.982	0	554.444	16.366
Facility Emp. (L1)	1,777[1]	265.853	1882.392	1	47000	19.447
Revenue[2] (L2)	1,026[1]	2,592.223	13,616.280	.041	226,094	11.95
Firm Level (L2)	1,026[1]	1.878	1.363	1	12	2.808

[1] *Because this is a multi-level model, there are a different number of cases for each level. This fact does not indicate missing data.*
[2] *In millions.*

4. Methodology and Results

Multilevel modelling is a useful tool when one has data that reflect clearly differentiated levels of social behaviors that are dependent on each other, the classic example being that of classrooms nested in schools. In this project, we have cross-sectional data associated with facilities (Planned and Fugitive Emissions, Facility Employees, NAICS Codes, Production Ratio) and firms (Firm Credit, Revenue, Small Business, Subsidiary Layer, Public) for 2016. Facilities are nested in firms because firm owners or managers run the facilities for business purposes and by firm-specific business practices. In fact, the ICC for the initial model of Planned Emissions is .84 and the ICC for Fugitive Emissions is .79, meaning that 84% and 79% of the variance in the models is explained by differences between firms, making multilevel modelling a good choice for this analysis.

Additionally, because these data break the assumption of independence, we should not run it using OLS, which would also conflate the interdependent levels (facilities and firms) (Hox 2010; Snijders and Bosker 2012). Without multilevel modeling in cases with non-independent observations the analysis may result in deflated standard errors leading to Type 1 error, or the possibility of false significance. An unstructured covariance matrix is employed here, which implies no assumptions of independence between variables so each variance and covariance are estimated uniquely from the data (Snijders & Bosker 2012).

One of the distinguishing characteristics of multilevel modelling is that the error term is partitioned into variances associated with each level of analysis. These variance terms, which will be reported with the results, offer information on the data in addition to the typical coefficients. In effect, a multilevel model is a heteroskedastic model, one which allows the exploration of the variance to understand patterns in the error term that reflect not only the potential effects of coefficients (slopes), but perhaps also of variables not employed in the model (Snijders & Bosker 2012). Unfortunately, there were not many level 1 variables in the Chapter 3 models, and so there will not be any random slopes in this analysis.

Most of the continuous variables in the model were logged because right skews are very high (see Table 3). This resulted in great improvement in the model fit of the Planned Emissions Model, and modest improvement in the model fit of the Fugitive Emissions Model (see Table 3.5). As a result, the interpretation of the coefficients should not be made in terms of specific units, but more general observations of proportional increases or decreases in effect. The variables are not centered in this study, despite the advice of both Snijders & Bosker (2012) and Hox (2010), because the data have already been transformed with the natural log, and therefore use of specific measures is not possible. Centering it to provide for better interpretations did not appear to be a meaningful exercise. Analysis was run using Stata/SE 13.1.

Table 3.5, AIC versus BIC of Logged and Unlogged Models

Models	AIC	BIC
Planned Emissions Model	87,454	87,608
Planned Emissions Model (logged continuous variables)	34,228	34,395
Fugitive Emissions Model	55,155	55,302
Fugitive Emissions Model (logged continuous variables)	35,963	36,131

Results

Five models were run for each dependent variable (Planned Emissions and Fugitive Emissions) with independent variables added hierarchically. The first model is the null model, the variables of interest are added in the second model, the interaction term is added in the third model, the quadratic and cubic terms are added in the fourth model, and the remaining controls are added in the fifth model. The NAICS term causes the model to be quite long, so short versions are given in this chapter, and the two entire models are available in the Appendix.

The question we are asking is whether Risky Firm Credit, Firm Revenue, Facility Employees, and Subsidiary Levels are associated with significant effects on Planned and Fugitive Emissions while controlling for governance, small business, and type of production. Through this statistical exercise, we are trying to ascertain what size and structural aspects of firms and facilities may be associated with increased Planned and Fugitive toxic emissions as a proxy for sustainability generally. To further test whether large multi-subsidiary corporations release more emissions Firm Revenue and Firm Levels are interacted. Facility Employees is tested for nonlinear effects. We will go through each hypothesis in turn.

H1: High credit risk facilities will produce more toxic emissions.

For Hypothesis 1, that facilities with a poor resource situation will produce more toxic emissions, for Planned Emissions, Risky Firm Credit is positive and marginally significant once the controls are introduced (Table 3.6, Model 5). This indicates that Hypothesis 1 is somewhat supported: firms undergoing financial problems will have the tendency to produce more toxic emissions as part of their normal production process.[13]

This was not found for Fugitive Emissions (Table 3.7), however, which appear to be unaffected by Firm Credit Riskiness in this model. It is interesting that when the controls are

Table 3.6, Multilevel Regression, Planned Emissions as the Dependent Variable, Short Models

	(1 Null) Planned Emissions	(2) Planned Emissions	(3) Planned Emissions	(4) Planned Emissions	(5) Planned Emissions
High Credit Risk Firms		0.168	0.155	0.302	0.551*
		(0.324)	(0.324)	(0.320)	(0.311)
Firm Revenue (log)		0.168**	0.097	0.023	0.062
		(0.066)	(0.078)	(0.078)	(0.093)
Subsidiary Layers		0.037	-1.812*	-1.407	-2.663**
		(0.089)	(1.093)	(1.083)	(1.065)
Facility Employees (log)		0.121**	0.120**	-1.381***	-0.634**
		(0.047)	(0.047)	(0.332)	(0.321)
Firm Revenue X Subsidiary Layer			0.080*	0.064	0.113**
			(0.047)	(0.047)	(0.046)
Facility Employees X Facility Employees				0.524***	0.356***
				(0.073)	(0.070)
Facility Employees X Facility Employees X Facility Employees				-0.044***	-0.033***
				(0.005)	(0.005)
Public					-2.031***
					(0.464)
Small Business					-1.494***
					(0.423)
Constant	3.234	-0.308	1.552	3.148**	5.900***
	(0.262)	(1.103)	(1.556)	(1.570)	(1.996)
Lev 2 SD “Between” C	7.974***	7.900***	7.886***	7.890***	7.607***
	(0.197)	(0.196)	(0.196)	(0.195)	(0.190)
Lev 1 SD “Within”	3.505***	3.504***	3.504***	3.445***	3.245***
	(0.035)	(0.035)	(0.035)	(0.034)	(0.0326)
Observations	6,044	6,044	6,044	6,044	6,044
AIC	35,036	35,023	35,022	34,853	34,205
BIC	35,056	35,070	35.076	34,920	34,380
R^2 Level 1		0.016	0.019	0.023	0.099
R^2 Level 2		0.017	0.020	0.021	0.090

*Standard errors are in parentheses; *** p<0.01, ** p<0.05, * p<0.1; R^2 is based on Snijders & Bosker (2012). Please see the Appendix for the long version of the models, which includes NAICS codes.*

[13] Interestingly, in this analysis, both Public and NAICS code may function as suppressor variables for Risky Firm Credit, as Credit becomes marginally significant when they are added to the model. In fact, in Chapter 4, Medium Sustainability Rhetoric appears to function as a suppressor variable as well in that its addition causes Risky Firm Credit to attain significance when added, see A.4. These are areas of future analysis.

added, Risky Firm Credit turns from positive to negative for Fugitive Emissions, which may be a point to pursue in a later iteration of the project.

H2: Larger firms will produce more emissions.

Hypothesis 2, which predicted that larger firms would produce more toxic emissions was supported for Planned Emissions as a coefficient in Model 1 where it is positive and highly significant, and unsupported for Fugitive Emissions, where not only are the coefficients not

Table 3.7, Multilevel Regression, Fugitive Emissions as Dependent Variable, Short Models

	(1 Null) Fugitive Emissions	(2) Fugitive Emissions	(3) Fugitive Emissions	(4) Fugitive Emissions	(5) Fugitive Emissions
High Credit Risk Firms		-0.090	-0.127	-0.145	-0.338
		(0.371)	(0.371)	(0.371)	(0.360)
Firm Revenue (log)		0.083	-0.095	-0.100	-0.131
		(0.073)	(0.087)	(0.087)	(0.104)
Subsidiary Layers		0.223**	-4.309***	-4.044***	-4.552***
		(0.102)	(1.203)	(1.202)	(1.192)
Facility Employees (log)		0.089	0.087	-1.639***	-1.377***
		(0.055)	(0.055)	(0.388)	(0.375)
Firm Revenue X Subsidiary Layer			0.196***	0.185***	0.203***
			(0.052)	(0.052)	(0.051)
Facility Employees X Facility Employees				0.436***	0.384***
				(0.085)	(0.082)
Facility Employees X Facility Employees X Facility Employees				-0.030***	-0.027***
				(0.006)	(0.005)
Public					-0.904*
					(0.524)
Small Business					-1.056**
					(0.484)
Constant	0.342	-1.908	2.701	4.451**	9.287***
	(0.266)	(1.208)	(1.715)	(1.753)	(2.238)
Level 2 SD "Between"	7.968***	7.916***	7.903***	7.903***	7.632***
	(0.203	(0.203)	(0.202)	(0.202)	(0.198)
Level 1 SD "Within"	4.084***	4.083***	4.078***	4.066***	3.842***
	(0.041)	(0.041)	(0.041)	(0.041)	(0.039)
Obs.	6,044	6,044	6,044	6,044	6,044
AIC	36,604	36,597	36,585	36,557	35,943
BIC	36,624	36,644	36,638	36,625	36,117
R^2 Level 1		0.010	0.013	0.015	0.089
R^2 Level 2		0.011	0.014	0.015	0.087

Standard errors are in parenthesis; **** $p<0.01$, ** $p<0.05$, * $p<0.1$*

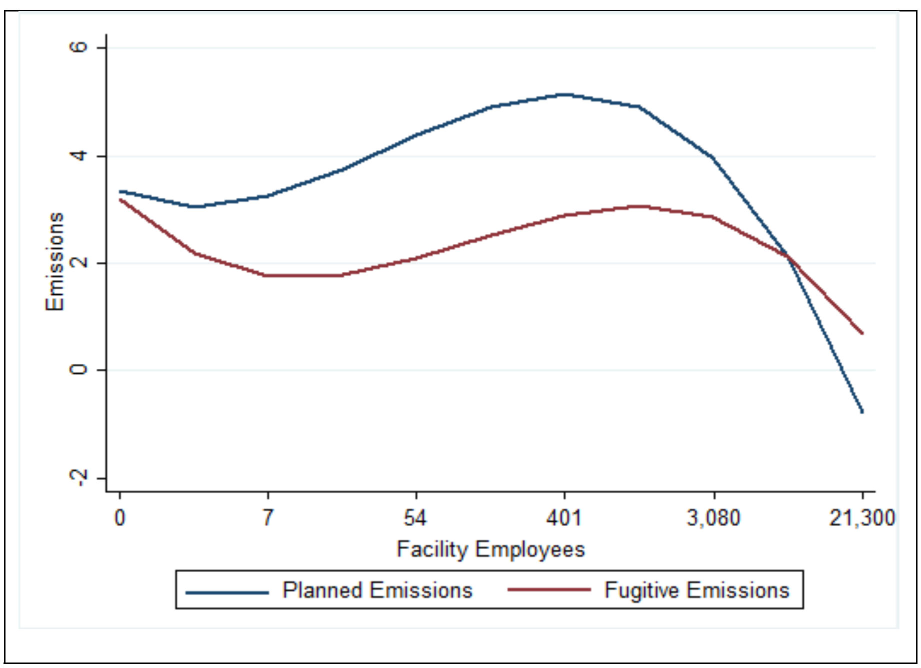
Please see the Appendix for the long version of the models, which includes NAICS codes.

significant, but they are negative. This topic will be explored further when the interaction is discussed.

> *H3: The more facility employees, the higher emissions to a specific tipping point where presumably the adoption of sustainability technologies and programs will start to drive emissions down.*

Hypothesis 3, which predicted that larger facilities would produce more toxic emissions was supported for both Planned Emissions and Fugitive Emissions (see Tables 3.6 and 3.7) where Facility Employees is positive and significant for both dependent variables. In addition, as predicted, the cubic function of Facility Employees is highly significant. The graph (Figure 3.1) indicates that as the number of Facility Employees increases toxic emissions also increases to a tipping point after which increased numbers of employees reflect decreased emissions. In addition, there is an initial curve that indicates that the smallest firms appear to decrease

Figure 3.1, Cubic Graph of Facility Employees



emissions when they increase number of employees. The curve for Planned Emissions is both higher, and far more steep in descent for larger facilities than that of Fugitive Emissions.

H4: Firms with more subsidiary layers will release more toxic emissions.

Hypothesis 4, which said that firms with more subsidiary layers will release more toxic emissions was not supported for Planned Emissions, but was supported for Fugitive Emissions, which show positive significant coefficient in Table 3.7.

H5: Large firms with more levels will release more toxic emissions.

Hypothesis 5, which said that larger firms with more layers will release more toxic emissions was supported for both Planned and Fugitive Emissions (see Figures 3.2 and 3.3). Here we see that the more subsidiary layers, the larger effect of Revenue on both Planned and Fugitive Emissions. In fact, Fugitive Emissions has a somewhat sharper and higher slope. Because we can

Figure 3.2, Effect of Firm Revenue by Subsidiary Layers, Planned Emissions

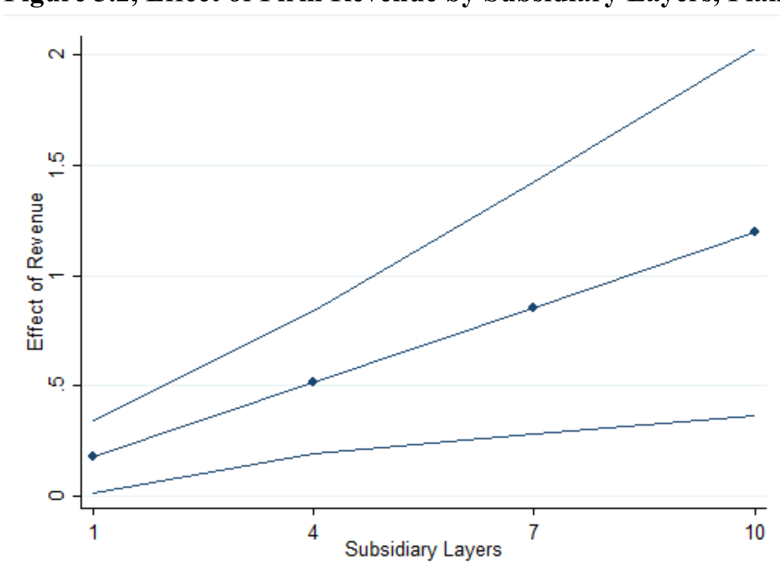
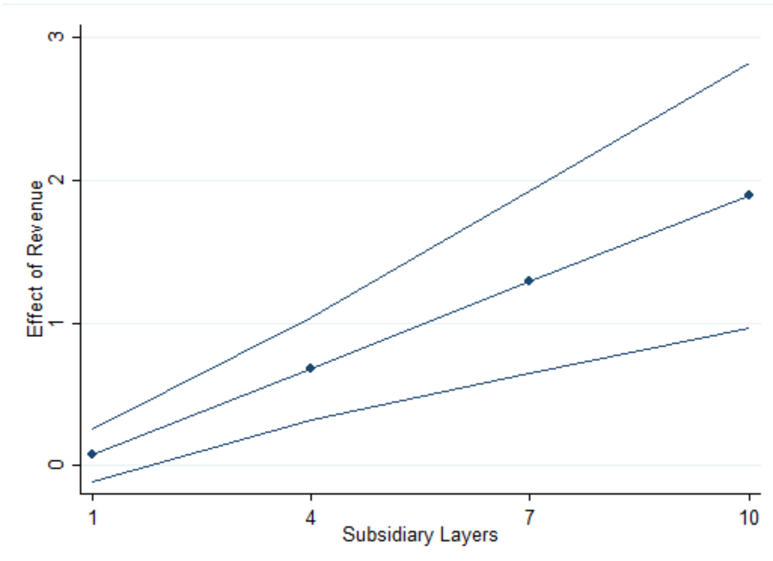


Figure 3.3, Effect of Firm Revenue by Subsidiary Layers, Fugitive Emissions



see that the confidence intervals border and dip below 0, especially for Fugitive Emissions, these slopes are not as significant at the lower levels, and they become quite wide at upper subsidiary levels where there are fewer firms.

Finally, as an interesting side note, and perhaps an avenue for future research, the control Public is highly significant and negative for Planned Emissions, indicating that the emissions of privately owned firms are substantially higher than publicly owned firms, taking into account the effects of the other variables

5. Analysis

Findings for this project indicate that resources, size and structure of facility and firm are associated with increased toxic emissions, meaning decreased sustainability. Risky Firm Credit is positive and significant for Planned Emissions (when all variables in the project, both chapter 3 and chapter 4 are added), indicating that firms with medium or poor credit are associated with more toxic emissions. The argument made here is that when firms are under financial pressure managers may make decisions based more on organizational survival and less in terms of legitimacy considerations such as increasing sustainability. In order to check this argument further, it might be useful to next add an interaction between Risky Credit and Production Ratio (or the ratio of chemicals production of chemicals in the past year to chemicals production in the present year) to check on whether Risky Credit is associated with increased production, since higher production would naturally lead to higher emissions. In this way, we could perhaps more closely pinpoint whether Risky Credit increases emissions because of differences of equipment, training, or protocols in the factory.

Subsidiary Layers is initially insignificant, when added to the model before the interaction, however when interacted with Firm Revenue, we get some added detail. For both Planned and Fugitive Emissions, the influence of Subsidiary Layers depends on Revenue: increased Layers with increased Revenue is associated with higher Planned and Fugitive Emissions. Theoretically the wealthiest firms can implement the most advanced sustainability technology and technique in their plastics facilities, but wealthy firms with more subsidiary layers apparently do not do so. This finding replicates the conclusions of Prechel & Zheng (2012) for plastics firms. Wealthy firms with more subsidiary layers, likely engaging in the Multi-Subsidiary Layer Form, as associated with increased toxic emissions.

Perhaps most interestingly, Facility Employees are associated with decreased emissions for very small facilities and very large facilities, and increased emissions for medium sized facilities. It is very likely that at the lower end increased numbers of facility employees indicates a larger number of people available to accomplish work in a systematic way, and perhaps to attend better to safety concerns. At the upper levels, emissions may diminish due to an increased number of employees available to carry out sustainability programs. It may be instructive to interact Facility Employees with Revenue to ascertain whether larger facilities are associated with larger and/or wealthier firms.

This result may reflect the two narratives found in the literature, that larger organizations produce more emissions, yet the largest may be able to invest in emissions-reducing technologies or programs and so might have lower emissions. An unreported regression involving firms measured by number of subsidiaries and facilities indicated a similar cubic function, so future directions for this work are clear.

Finally, given that most studies of toxic emissions lump Planned and Fugitive Emissions together, an implicit question of this study has been, is there a difference in the behaviors that produce Planned and Fugitive Emissions? Logically, one would think so since Planned and Fugitive Emissions are the results of different, but related activities: Planned Emissions are the result of forethought and prior organization to manage emissions while Fugitive Emissions are the result of unplanned events. One might think that the better managed Planned Emissions, the fewer Fugitive Emissions. The data do bear out the idea that these two types of emissions may be affected by similar social processes, and yet are also subject to different influences. For most variables the results between Fugitive and Planned Emissions reflect each other, although Fugitive Emissions is not as likely to be significant, and the model fits it less well. Different variables should be introduced for Fugitive Emissions in order to tease out the meaningful differences between associated social processes.

Results of this analysis indicate that size, resources, and structure matter when we consider the emissions of plastics firms, but what about the effects of plastics industry association membership? That is the subject of Chapter 4.

Chapter 4, Plastics Firms and Industry Associations

1. Introduction

In the previous chapter, I examined the ways that size, resources, and structure of a plastics firm may be associated with differences in toxic emissions releases. In Chapter 4, I turn to the relationship between plastics firms and industry associations; organizations formed by member firms to provide centralized services to an industrial field. Because there is little written about industry associations in the literature, descriptive information will be introduced, based primarily on the rather large number of industry associations that serve the plastics industry. Additionally, a statistical analysis will be run to explore whether industry association variables demonstrate any association with firms through the analysis of company toxic emissions. The variables of interest in this chapter include industry association membership, industry association involvement with sustainability, and industry association size.

The broad question this chapter explores is whether industry associations, as private centralized institutions, are associated with effects on member firms through the development of private decentralized institutions, or norms (Ingram and Clay 2000). It will be argued that industry associations, through formal and informal knowledge services, offer information and learning experiences to firm personnel who both go on to implement that knowledge in firm operations and also participate in these same services as instructors and mentors, thereby creating communities of technical expertise. The broad sociological question, and the institutionalist question, is whether membership in an industry association, as a community of knowledge, is associated with norms that have an effect on firm behavior such that evidence can be found in the emissions data of member firms.

Association membership here will be treated as a socio-cultural decision because for most firms, the resources available through association membership are economically "soft:" access to manufacturing and operations education, networks, and perhaps a say in the field's political voice. These soft resources are paid for annually by the for-profit firm in cold hard cash that could be put toward other useful things: profit, equipment, mortgages, or product research. If membership in industry associations is reflected in firm emissions data, this will comprise some evidence for the sociological premise that people are more than classically rational machines. Even the most economically-driven members of modern society, business owners and managers, who are thought to survive on the basis of classically rational financial calculations, may choose to practice their businesses as part of industry associations, organizations that offer soft benefits, and which comprise a society of their rivals and competitors. Even though it might be argued that these soft benefits can be quantified toward a more successful firm, the fact that only 31% of the sample firms belong to industry associations indicates that not all firm owners and managers agree.[14]

The study of industry associations is important given the enormous influence these well-funded organizations currently wield in US government (Barley 2010) and beyond, for example in international climate change talks (Pulver 2007; Goldman and Rogerson 2013). It is not that industry associations are the only large and influential organizations attempting to implement an agenda in government, however they have played an outsized role in two recent society-wide negotiations about human safety: cigarettes, global warming. Industry associations would be counted among the organizations Perrow warned us of in 1997: capable of promoting not only

[14] Although this study does not have data on firm decision to join industry associations, this topic, and the "chicken-egg" nature of industry association effects will be discussed later. Anecdotal evidence from association personnel indicates that some firms do hesitate to join out of concern over socializing with rivals.

their own interests, but interests that are directly counter to those of consumers and of voters. This dissertation therefore will provide information on industry associations as both an interesting sociological type of "peak" organization (Barley, 2010) as well as a powerful player in current events that should bear careful scrutiny.

This chapter is divided into three sections. The first section introduces industry associations as a specific type of organization and relates it to institutional theory. The second section explores industry association website sustainability rhetoric as a means to introduce the variables of interest and the hypotheses. This leads to the third section which conducts a statistical analysis of such independent variables as volume of industry association website sustainability materials, the existence of sustainability committees, and the size of industry associations against the dependent variables firm toxic emissions. Hypotheses are explored using two multilevel models with Planned and Fugitive Emissions as the dependent variables, based on plastics facilities (level 1), parent firms (level 2), and dummy variables representing whether sample firms belong to plastics industry associations, as well as some specific characteristics of the associations. The results are encouraging in that industry association variables concerning sustainability appear to reflect influence on the way member firms manage toxic emissions, although not always in the ways one might expect. Firm members of industry associations on average, produce more Planned toxic Emissions that nonmembers, and fewer Fugitive Emissions. Members of industry associations with sustainability committees on average, also produce more toxic emissions. On the other hand, firm members of industry associations with high sustainability website content tend to have lower emissions.

Institutionalism and Industry Associations

Institutional theory emphasizes the shared nature of social life organized around complexes of traditions and norms that attain a "rule-like" "taken-for-granted" quality and which sociologists often conceptualize as divided into large general social areas, for example: higher education, the military, the Catholic Church, and the mental health system.[15] Is manufacturing an institution? I would argue that it is. Factories, at least in the US, have many similar operating requirements and procedures (product research, supply chain logistics, creating finished products, dispensing of waste and/or remnants, packaging and selling the finished goods). Products are created at facilities by similar groups of people across product types: engineers, designers, sales people, buyers, supervisors, and workers. It is highly likely that the task at hand for manufacturers uniquely shapes their attitudes, expectations, and behaviors just as it does for mental health workers and university professors. It is also likely that people who work in manufacturing are bound by customary behaviors and expectations that they engage in quite unconsciously, but which are very important to how routine life unfolds.

From the Institutionalist point of view, an industry association may fill an important coordinating role in an industrial field, which is a conceptualization of all the firms and organizations that engage in a specific industry (or subindustry), and may include suppliers and vendors (Fligstein 1990). Industry associations, which create platforms for the gathering and sharing of information between owners, managers, and technicians of member firms, obviously form important network hubs, or portals which capture field dynamics not only in their operation, but also in their organization. Because not all firms belong to the industry associations affiliated with any particular operating area, an industry association does not define a field, however the

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[15] Institutions may or may not involve organizations.

presence of an industry association, whose active interest is the field, and the health and coordination of the firms in the field, must certainly change the dynamics of any field that has one.[16]

Industry associations are a meaningful example of institutional power in the very economic area of manufacturing, and therefore a unique opportunity to demonstrate the importance of social decision making, even in the midst of a milieu that strongly values rational economic analysis. Not only are industry associations the most important type of organization that most Americans have never heard of, they also appear to have influence on the sustainability operations of member firms, which is an example of measurable institutional effects.

3. What is an Industry Association?

An industry or trade association is a nonprofit organization created to assist a group of firms in one, or a few closely aligned industries by offering services that are more easily provided by a central source than by firms themselves (or more cheaply apropos of Williamson 1994), such as industry knowledge cultivation and education, insurance services, public relations services, government relations, and the development of industry-wide standards and best practices.

Industry associations have historically been formed because the people who run firms see the need for an organization to coordinate some aspect of an industrial field. Before the Progressive Era industry associations were formed to restrain destructive competition, and were much involved in price-fixing, market manipulation, and output restriction (Galambos 1966). Early 20th century Progressive trust-busting increased regulations on trade associations, and until

[16] See for example, the efforts of the nascent American Association of Junior Colleges (AAJC) to forge a common identity and rationalize organizational systems among junior colleges from the 1920s to 1970s (Brint and Karabel 1989), or Galambos on efforts of garment industry associations to upgrade facility accounting practice in the 1930s (1966).

WWII, industry associations were often formed in the attempt to set industry standards (Mack 1991) -- but they were still occasionally caught in episodes of price-fixing (see Galambos 1966). There is evidence in old issues of the PIA/SPI[17] newsletter that it (and presumably other industry associations) worked closely with the US government to produce goods for the WWII war effort and were involved with the operations of the early New Deal.[18]

A shift in role of industry associations toward representation to government largely came in response to the increased centralization and consolidation of the federal government and importance of national economic decision making after WWII (Hanneman 2012). As the importance of centralized environmental decision making grew during the 1970s many industry associations relocated to Washington DC (Barley 2010; Mack 1991), reflecting the growing importance of influencing legislation during the period of the formation of environmental interest groups and the formulation and passing of important pro-environmental legislation (Barley 2010). Today 42% of the plastics industry associations studied are located in Washington DC or are a drivable distance away (like Arlington VA, or Crofton MD), with an average driving time of 15.72 minutes when traffic is light.

Modern industry associations run on budgets provided by participating firm dues (Barley 2010) and are governed by industry association staff and employees of member firms, usually in a committee structure dominated by the board of directors (Hanneman 2012), which is often populated by the employees, owners, or managers of large firms. Industry Associations have played an important role in the development of US business (Mack 1991) without much

[17] PIA/SPI will be used to refer to the largest plastics industry association, the Plastics Industry Association, which used to be called The Society of the Plastics Industry.
[18] As chronicled in newsletters of the Society of the Plastics Industry during the early 1940s. These newsletters are available at the Hagley Museum and Library, 298 Buck Road East Wilmington, DE 19807.

recognition by the public, or academia (Damsgaard and Lyytinen 2001) – there are very few formal studies of industry associations in the literature.

Industry associations provide an array of services that can generally be grouped as follows:

1) Coordinating services across an industry field, for example, the formation of standards (Galambos 1966), best practices (Greenwood, Suddaby and Hinings 2002), or pan-industry research (Damsgaard and Lyytinen 2001). Industry associations also coordinate self-regulation efforts, such as the Responsible Care program (King and Lenox 2000).

2) Information services, including industrial training for small and medium organizations (Greenwood et al. 2002), compliance information for government regulations, and the formation of platforms (conferences, meetings, social media) on which member employees can express their views, share their knowledge, and receive and process new information (Fagan-Watson, Elliott and Watson 2015; Hanneman 2012).

3) Public relations services (Elsbach 1994; Gable 1953), including large public campaigns, government relations (Andrews and Edwards 2004) and in particular, lobbying on behalf of the industry (Fagan-Watson et al. 2015; Gable 1953; Grier, Munger and Roberts 1994; Holt, Anthony and Viney 2000) as well as providing specific industrial expertise to governments, particularly in the shaping of regulations and legislation (Aplin and Hegarty 1980).

In many ways industry associations are transmission sites of information. On one end, information about the industry is gathered from the owners, managers, and employees of member firms through committees, conferences, surveys, and volunteer work, and this information is presented to the government through lobbying, testimony, reports, and advice on legislation, as well as to the public and the firms themselves through publications, workshops, training, and websites.

Industry Associations and Government Relations

Among the many services provided by industry associations is the work they do with government on behalf of member firms seeking to shape their environments (Barley 2010). In fact, industry associations have a great deal of influence on the creation and implementation of legislation (Goldman and Carlson 2014). This power is partly created by the association representation of a slice of the electorate with unified interests, and the means to fund political campaigns, public relations strategies, and to influence affiliated voters. This power is also created by the knowledge of industry association membership about the technologies and production patterns of the industry. Clearly industry associations, as a specific type of knowledge-conserving institution, are very valuable in the technical proficiency they can bring to a legislature interested in regulating, for example, the toxic chemicals used in the creation of PVC. On the other hand, the Union of Concerned Scientists found that although many firms rely on representation by industry associations, they do not always agree with the view of the associations, especially as it regards sustainability and climate change (Goldman and Carlson 2014).

The PIA/SPI has had a long history with government relations, starting during WWII in combined efforts to produce goods for the war effort[19], but perhaps more familiarly in the aftermath of a 1959 scandal involving the deaths of several children in newly introduced plastic

[19] As chronicled in newsletters of the Society of the Plastics Industry during the early 1940s. These newsletters are available at the Hagley Museum and Library, 298 Buck Road East Wilmington, DE 19807.

film dry cleaning bags. The PIA/SPI worked for years afterward to contain the growth of local and state regulation against these bags in what threatened to lead to a patchwork of legislation across the country in what has become known as "The First Bag Wars" (Meikle 1997). PIA/SPI has been involved in all the biggest plastics environmental battles since, from the first realization that plastics degraded to smaller and smaller particles that could interfere in the marine ecosystem, to the growing volume of plastics in municipal waste streams, to false claims of nonflammability of polyurethane and polystyrene (Meikle 1997) to "The New Bag Wars," battles over single-use consumer plastic bags and straws. Both the PIA/SPI and the American Chemistry Council (ACC), two of the biggest and most powerful plastics industry associations, as well as the Western Plastics Association (WPA), have worked assiduously to kill the local plastic bag bans proposed by many cities, counties, and states (Doucette 2011; Toloken 2020).

Of course, industry associations are not only focused outward on the organizational environment: they also provide services to members through the educational and community platforms they create through conferences, committees, newsletters, and presumably social media. There is a sense that industry associations create and foster occupational communities within fields.

Industry Associations and Member Firms: A Knowledge Collectivity

Perusal of industry association materials makes it clear that one important goal is to form a community of knowledge among members. Industry associations often represent industries which work with very specific technologies that are not (or not fully) taught in higher education, and must be disseminated by practitioners within the industrial field. Industry associations almost universally offer white papers, standardization information, and other specific technical guidance for practicing in the field. Conferences, an almost universal feature of industry associations, allow members to instruct each other on a variety of technical topics, as well as industry-specific business practices and concerns. Some industry associations take field education as a more central concern, and offer formal coursework to member firm employees, for example, the CCAI supports the Chemical Coaters Association International Finishing Education Foundation which provides online and in-person education on finishing, as well as scholarships (Chemical Coaters Association International 2020). The Pressure Sensitive Tape Council offers three courses that cover the fundamentals of PSA Tapes and advanced adhesive technologies. Such coursework obviously supports both employer needs by providing necessary education to employees, while also improving standardization and disseminating best practices.

Industry associations therefore often conserve technical knowledge on behalf of the group, becoming informal knowledge institutions. This role in the transmission and dissemination of related knowledge, may put an industry association at the center of a larger trans-organizational sort of community of practice, perhaps a knowledge collectivity (see for example, Lindkvist 2005). Most literature on community of practice is based on intra-firm communities, people who work together within a firm, sharing knowledge and teaching each other (Brown and Duguid 2001; Lindkvist 2005), however, there is likely a sort of knowledge community based in industry associations that bears further investigation. It is likely that such an industry association knowledge collective would produce reciprocal private decentralized institutions, transmitted from firm personnel to the industry association through committee work, networking, and workshops, and back to firm personnel again. This is especially likely because most industry association instruction is between firm personnel – that is, volunteer firm personnel tend to teach technical breakout sessions and run committees. This may lead to a similarity of techniques and best practices between member firms, especially as compared to non-member firms.

4. Plastics Industry Associations

Within the institutionalized elements of manufacturing, there are several industrial fields, for example, steel, glass, and plastics, and within plastics, there are several subfields, such as plastics bottle manufacturing, paint and coatings manufacturing, and plastics pipe manufacturing. Each of these areas are similar: they use resins to create specific products but they do so through different technical processes, and for different end markets. Based on previous unpublished network analysis of the participation of plastics firms in industry association committees, the subfields have network characteristics, with dominant firms, cliques of firms, perhaps formed by relationships among owners and managers, and specific knowledge diffusion patterns (Jennings and Zandbergen 1995). It is likely that much of the dominance, relationship, and diffusion patterns occur within and are encapsulated by industry associations.[20]

Not all firms and facilities belong to industry associations, of course. In this study sample, only 313 of 1026 firms belong to industry associations, or 31% of firms, which translates to 46% of facilities. Firms not belonging to industry associations are on average smaller, with the mean size of 55 establishments[21] (median: 1) as opposed to 186 establishments (median: 6) for those firms that do belong to industry associations (see Table 4.1).

Quite a few firms in this sample (119) belong to more than one industry association, and these tend to be larger, with a mean of 343 establishments (median: 58). Of the 119 firms belonging to 2 or more industry associations, 74, or 62%, belong to either the PIA/SPI or the ACC (American Chemistry Council), the two subfield-spanning industry associations, or both. As shown in table 4.1, firms belonging to one or more industry associations tend to be smaller than

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[20] See a complete list of plastics industry associations featured in this study, as well as size information in the Appendix.

[21] Establishments include both facilities and subsidiaries.

those belonging to the PIA/SPI or ACC, which are smaller than those belonging to both field-spanning industry associations. For the plastics industry, then, the structure of industry association membership appears to reflect the industry as a whole: a network of related subindustries loosely tied together by two larger industry associations reflecting the primacy of resin and chemicals for the entire group. Larger, dominant firms tend to belong to multiple industry associations (indicating multiple product lines), as well as the field-spanning dominant industry associations, with the largest belonging to both.

Table 4.1, Sample Firms that Belong and Do Not Belong to Industry Associations

	Frequency	Percentage	Mean Size (Facilities and Subsidiaries)	Median Size (Facilities and Subsidiaries)
Nonbelonging Firms	720	70%	55	1
Belonging Firms	306	30%	186	6
Firms Belonging to 1 IA	197	19%	93	3
Firms Belonging to 2+ IAs	109	11%	343	58
Firms Belonging to either the ACC or the PIA	62	6%	401	64
Firms belonging to both the ACC and the PIA	13	1%	559	292

Plastics Industry Associations and Sustainability

Even a casual reader of news at the beginning of the 21st century would shortly become aware that sustainability has not attained the "rulelike quality" that institutionalism describes (Jennings and Zandbergen 1995), rather it is very much a matter of divergent opinion and activity not only across firms, but across industry associations. This is what makes sustainability fascinating in terms of sociological analysis: it is an example of a set of beliefs and actions that society at large, and industry associations specifically for this study, are grappling with in real time. Naturally the current contentious state of play of sustainability is reflected by complexities of organizational behavior on the part of plastics industry associations. One example of this complexity is the state of the Responsible Care Program, which is associated with the ACC (the American Chemistry Council, formerly, the Chemical Manufacturers' Association).

The ACC requires members to participate in the relatively well-known Responsible Care Program, which was formed as a way to provide self-policing to the chemicals industry in the wake of the 1984 Bhopal disaster and concurrent US concern over the appropriate use and storage of toxic chemicals (American Chemistry Council 2020; King and Lenox; King and Lenox 2000; Vidovic et al. 2019). Although Responsible Care was formed in the wake of Bhopal, it is often presented as a program that has emerged from the natural environmental concern of the ACC and member firms (see, for example, American Chemistry Council 2020). The ACC, which features many large resin producers, advertises that member firms have accomplished a 44% reduction of hazardous pollutant releases over the last two decades, as well as decreased injuries and improved energy efficiency (American Chemistry Council 2020). Up until 2005, the program was criticized because it was performed on the 'honor system,' that is, firms set their own standards and performed the program in idiosyncratic ways, so a third-party audit was introduced (King and Lenox 2000). Recent statistical investigations into the efficacy of the third-party audit have shown that "at best" it did not help reduce emissions, and in fact, may have been associated with increases in emissions (Vidovic et al. 2019).

Of course, from the Neo-Institutional point of view, a program such as Responsible Care could be an exercise in ceremonial compliance to public and governmental legitimacy demands (see Meyer and Rowan 1977). Firm-level adherence to Responsible Care mandates could be loosely coupled to the production apparatus and procedure, leading to prominent program materials regarding sustainability, and even a third-party auditor, but little measurable success in terms of emissions reductions. The same can be implied for industry associations with large amounts of sustainability materials on their websites. The existence of such materials do not necessarily imply that toxic emissions are being reduced, or that any other sustainability measure is being enacted for that matter.

After all, industry associations representing firms that are endangered by the changing concerns of society have been known to resist these concerns, sometimes fiercely. Tobacco industry associations, for example, fought the regulation of cigarettes tirelessly, because they were fighting for the existence of the industry they served. As another example, if read carefully, most accounts of the fight of the oil industry against global climate change measures continually mention action taken by the American Petroleum Institute and other oil industry associations (see, for example, see Oreskes and Conway 2010; Pulver 2007; Meyer 2020), and of course, that is no accident. The fight against climate change often calls out use of fossil fuels, and oil and gas industry associations fight for the survival of the oil and gas industry.

Similarly, the plastic bag wars of the last decade have been fought largely by the American Recyclable Plastic Bag Alliance (formerly the American Progressive Bag Alliance), which was originally spearheaded by the ACC, but moved to the PIA/SPI in 2011 (The Plastics News 2011). Millions of dollars have been spent in the campaign over the years (Lazarus 2014) battling against a patchwork of cities and states that have banned plastic bags. One perhaps surprising result of the growing movement to ban plastic bags has been a strong push by the ACC to increase the recycling of plastic film (The Plastics News 2011). This is a fascinating bifurcated response: on one hand the industry associations battle against local government action, and on the other, they work to find a technical way out of the battle, in this case by trying to improve recycling technology.

Industry Associations and How Sustainability is Expressed on Public Websites

A central question on this dissertation is whether industry association projected attitudes about sustainability are associated with sustainability as practiced by member firms. This is a complex question to conceptualize involving 1) assumptions of how industry associations operate and how they may influence firm employee behavior and professional and craft practice, and 2) how to conceive of and measure industry association expression of sustainability, and 3) how this relates to firm emissions data.

Because, as we have seen, industry associations exist in part to coordinate and distribute information about the field to member firms, it is highly likely that they also encourage, circulate, and even produce private decentralized institutions, or practices and norms, that provide templates for behavior by firm employees (Ingram and Clay 2000). Delmas and Toffel (2004) have reported that it is likely that the industry association position on sustainability and emissions will have an effect on how a firm handles emissions, and that industry associations which are pro-sustainability will both reflect the attitudes of firms, and influence firms toward this point of view. Certainly given the role of industry associations as knowledge collectives for their fields, it is very reasonable to assume that the industry association will not only present familiar perspectives on sustainability to firms, and also that these perspectives may have an effect on firms. This is a bit of a chicken and egg question however, because it is unknown whether a firm owner/manager would choose to join an industry association because its sustainability policy matches his or her preconceived views, or whether the firm joins and then is influenced by the industry association. Although there are many plastics industry associations, however, there are often only 1 or 2 industry associations for a specific subfield, so we would not expect that industry associations are competing against other industry associations for firm interest based on sustainability attitude, for example, but rather working to convince owners and managers of nonbelonging firms to join in the first place. There is some evidence that firms may gravitate to specific industry associations based on their own size, however, as was seen previously in terms of size of firm that joins the PIA/SPI and ACC. In addition, there is some evidence outside the plastics industry that firms may belong to industry associations while objecting to the association's basic sustainability posture (Goldman and Rogerson 2013).

Answering the question of why firms join industry associations would require a different and very valuable project, however given our understanding of the knowledge-conserving and distribution aspects of industry associations, it is likely that while some firms may join based on baseline similarities of interests and points of view, many firms join based on other values: access to information on government regulations, or market information, employee training, and the opportunity to lobby government.

Sustainability is the area of interest not only because it is important, but also because it is a large, controversial issue that industry is quite concerned about, and industry associations take a variety of stands on this subject (Goldman and Rogerson 2013), causing variance we hope to measure. For example, a recent study by the Union of Concerned Scientists found that industry associations representing industries that stood to benefit from a green economy were quite supportive of specific policy proposals to combat climate change, including the Edison Electric Institute, the American Wind Energy Association, and the Solar Energy Industries Association (Goldman and Rogerson 2013). The American Petroleum Institute, National Mining Association, and American Coal Council were less supportive of the same policy and questioned the science of climate change. The American Chemistry Council (ACC) was included in this study, and while it accepts the science regarding climate change, it does not support any specific legislation to help roll it back (Goldman and Rogerson 2013).

The next question is how to measure industry association sustainability? For the purposes of a dissertation, the sustainability expression needs to be easy and free to access. It needs to be something that all industry associations engage in so that there would be data for as many industry associations as possible. It was decided to measure the quantity of sustainability text on industry association websites because all plastics industry associations examined have websites with sometimes very large amounts of information for the public, including sustainability information.[22] Rather than interpret the text as being relatively pro-sustainability to whatever degree, it was decided to measure the quantity of text concerning sustainability.

Sustainability information to be found on plastics industry association websites includes a wide variety of types, including guidance information for member and non-member firms (which can get quite technical), as well as public relations information, statistics on the subfield, information on correct use of products, philanthropy, etc. The range of sustainability interests of the various industry associations represents the diverse nature of plastics companies and the many aspects of sustainability that exist. For example, while the ACC was the only industry association that emphasized the handling and emission of toxic chemicals as a specific aspect of sustainability through the Responsible Care Program, the Flexible Packaging Association (FPA) spent website space explaining how plastic packaging is lighter and therefore uses less fossil fuels to ship than glass containers. The PIA/SPI promoted the Clean Sweep Program, designed to stop the transmission of plastic pellets to waterways and oceans. The Plastic Pipe and Fittings Association (PPFA) promoted a certification program (Sustainable Manufacturing Conformity Assessment Program) that examines the following areas of firm performance: efficiency in energy and water use, waste in terms of packaging materials, material conversion, and product

[22] It should be noted that the project only looked at materials freely available to the public. Many associations also have extensive members-only areas that were not available for review.

materials, as well as plant safety and product safety (Kavanaugh 2014), which represent basic industrial concerns of sustainability (Dauvergne and Lister 2012; Haanaes et al. 2011; Andrady 2015).

Industry Association Website Data Gathering and Variables of Interest

To gather information on what would become the sustainability messaging set of variables, a team of nine undergraduate students were recruited to review and rate plastics industry association websites for quantity of sustainability messaging from Fall 2016 to Fall 2017.[23] In Fall 2016, the student team members[24] were educated about what industry associations were, what sustainability is, how plastics industry associations might write about sustainability, and assisted in searching for plastics industry associations. In Winter and Spring 2017, two or three students were assigned each industry association website with specific instructions on how to evaluate the website using a rating instrument (See Appendix 2 for the rating instrument). Ratings were evaluated after they were submitted, and occasionally sent back for re-evaluation if students appeared to have missed large areas of sustainability text. In this request for revision, students were simply asked whether they had seen specific page areas. On the second or third submission, student work was accepted.[25] Students met with the author in two teams, so they were "blind" reviewers in effect – they did not know who was assigned to evaluate which industry association.

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[23] The students rated 37 industry associations out of a possible 42.

[24] Eight of these were undergraduates from UCR, seven of whom got a year of credit for working on the project. The students included: Pierson Bian, Mireya Duarte, Claudia Garcia, Kendra Isable, Sharon Mendez, Alice Padilla, Mayra Santoyo, Rocio Vallejo, and Jocelyn Topete Villavicencio.

[25] Because the author was reviewing student work at each submission, and sending it back for revisions, she was aware of the relative size of each website being reviewed, and did not accept reviews that were not generally commensurate with website size. For example, one student would not review satisfactorily and these scores were thrown out because they did not in any way describe the websites. There is a baseline size measurement that can therefore be relied on.

Students were asked to evaluate the websites in two general ways. First they were asked a series of questions that had simple answers, for example, was sustainability mentioned at all, in any way, on the homepage, and did the industry association have a recycling committee, etc. Next, they were asked to rate the pages they read on a scale of 1-5:

0: no mention of anything like sustainability.

1: sustainability language is mentioned, not discussed.

2: sustainability appears and has 2-3 pro-sustainability lines.

3: sustainability has a longer vague paragraph, or a short paragraph with meaningful detail.

4: sustainability appears as a very long text, but is vague, or a few paragraphs with meaningful detail.

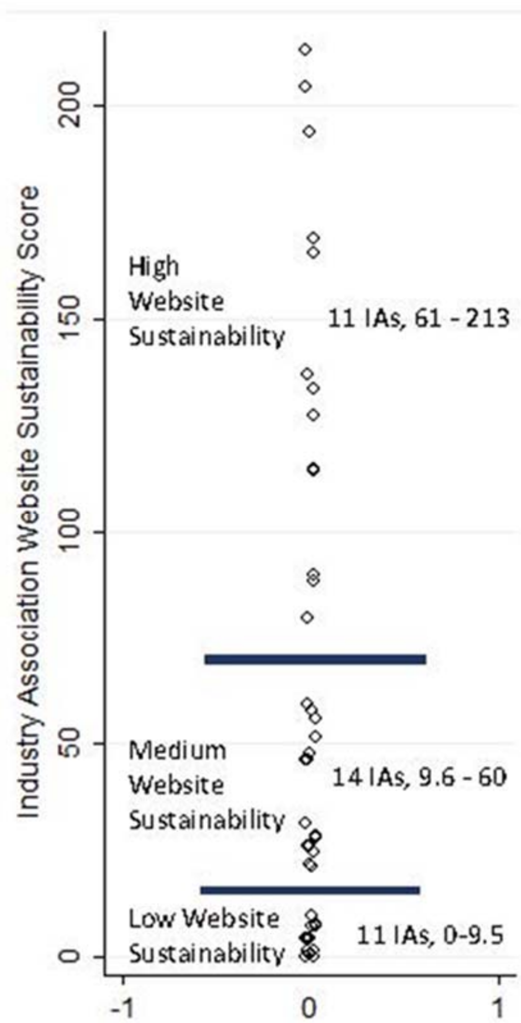
5: sustainability appears with a long text and generous, meaningful detail.

Due to the lack of clarity for some of these measures, as well as basic student frustration with the large amount of material, the resulting measures contain some measurement error.[26] This becomes obvious when one considers the gaps between raters' assessments of industry associations. Differences in ratings for the IAs range from .5 to 127 with an average of 3.74 and standard deviation of 25.89. On the other hand, while use of student raters has presented some obvious problems, potential bias in their work is certainly not derived from an interest in success (or failure) of the analysis, but more from boredom and busy schedules. In order to consolidate

[26] The effort to work with the student team was based on the effort to avoid bias. If the author had done the rating there may have been questions of bias as the work would have been accomplished by one rater, a person with a definite conflict of interests in terms of the results of the study.

the benefit of the student assistance and render the error less operational, the following measures were taken.[27]

Figure 4.1, Breakdown of Sustainability Rhetoric Scores from Plastics Industry Associations



The largest gaps between scores comprise the industry association websites with the most sustainability information, so it may be that the student reviewers became tired with the large amounts of information to read in these cases. Two steps were taken to lessen the impact of this error, first, each industry association set of scores were averaged. Next, scores were categorized into three general levels, Low (0-9.5), Medium (9.6 – 60) and high (61+) (See Figure 4.3). If the 36 reviewed industry associations were divided evenly, there would have been 12 per category, however there are two natural cut points near these scores that were used instead as the industry associations have definite clusters (see Figure 4.3). The result for this analysis is three dummy variables,

[27] The biggest lesson of the effort was not to use unpaid undergraduates as raters. The author is preparing to use web and documents scrapers to gain this data in the future.

Low Sustainability Rhetoric, which includes a 1 for all firms that belong to an industry association which scored between 0-9.5, meaning that this industry association had minimal or no website sustainability materials on its public website, and a 0 for all others[28] (please see Table 4.2 for numbers of firms that belong to each dummy variable). Medium Sustainability Rhetoric indicates a 1 for those firms belonging to an industry association that scored 9.6 – 60 for website sustainability materials and 0 for all others, and High Sustainability Rhetoric indicates a 1 for all firms belonging to an industry association that had a great deal of website sustainability material available to the public (scored at more than 61) and a 0 for all others.

Using these variables we can investigate hypotheses 1 and 2.

H1: Firms that are members of associations with a large amount of website sustainability material (High Sustainability Rhetoric) will have reduced emissions.

H2: Firms that are members of associations with a medium amount of website sustainability material (Medium Sustainability Rhetoric) will have reduced emissions, but at a greater rate than High Sustainability Rhetoric firms.

H3: Firms that are members of associations with a low amount of website sustainability material (Low Sustainability Rhetoric) will have the highest average emissions in comparison to High and Medium Sustainability Rhetoric firms.

In order to provide a more easily quantifiable measure of industry association interest in sustainability, an additional measure was added, the presence or absence of a sustainability committee in the industry association in 2016. The variable was gathered by the students

[28] Because firms can belong to more than 1 industry association, Website Sustainability Materials cannot be expressed as a categorical variable. Instead, it is expressed as three dummy variables.

alongside the website sustainability variables. Presence of a sustainability committee is assumed to provide evidence of member interest in field sustainability because committees are manned and run by firm members, ipso facto, the committee would not exist without member firm support. This is considered a different way of measuring industry association support for sustainability because while theoretically industry association staff can include information on the public website without member firm approval, it takes member firms to create and maintain a sustainability committee. It should be noted however, that sustainability committees work on a wide variety of sustainability issues, including greenhouse gases, energy efficiency, and recycling, not necessarily concentrated on toxic emissions. This leads to a third hypothesis.

H4: Firms that belong to industry associations with sustainability committees will emit fewer toxic emissions than non-member firms.

Sustainability Committee is a dummy variable coded 1 if a sample firm belonged to an industry association with a sustainability committee, and 0 otherwise.

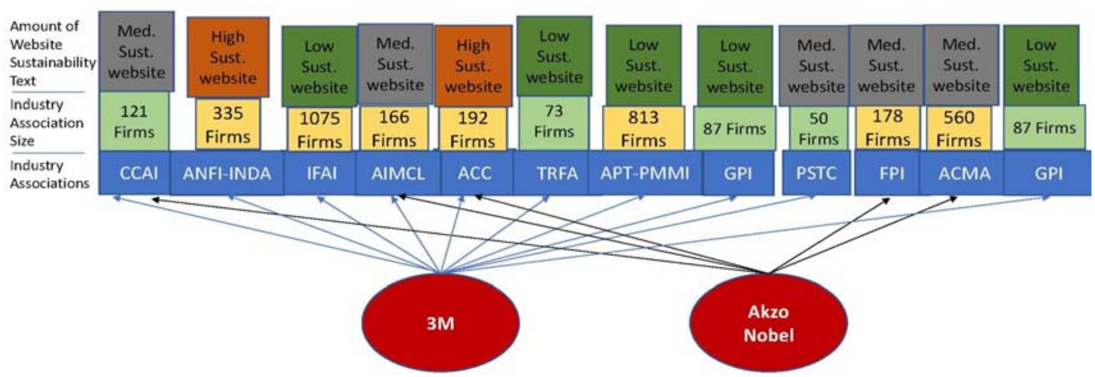
Finally, the variable Member is introduced to test whether industry association member firms are associated with higher or lower toxic emissions. The fact that no industry association created materials arguing against sustainability, and all expressed a universal interest in safety lead to Hypothesis 5.

H5: Firms that belong to industry associations will be associated with lower toxic emissions.

5. Dependent and Control Variables

Because firms often belong to more than one industry association, coding related variables was challenging. For example, 3M belongs to ten industry associations and Akzo Nobel belongs to five industry associations (See Figure 4.4). Each involved industry association has a different variable profile, for example, ANFI-INDA has 335 firm members and a large amount of sustainability content on its website whereas TRFA has 73 firm members and a low amount of sustainability content on its website. 3M belongs to both of these industry associations, which makes it difficult to assign 3M an industry association size value. Would 3M be coded as belonging to a large industry association (ANFI-INDA), or a medium industry association (TRFA)? Since it belongs to both, this is not a decision that can easily be made. Similarly, ANFI-INDA has a large amount of sustainability content on its website, and TRFA has a low amount.

Figure 4.2, Firms Belong to More Than One Industry Association



How then do we assign 3M a value for the sustainability content of its industry association?

A quick solution is to use dummies for these variables. Instead of coding each firm with one value for each industry association variable, each industry association characteristic was broken down into dummies reflecting those firms that share the value and those firms that do not. So, for example, all firms that belong to an industry association with high website sustainability are coded ‘1’ for High Sustainability Rhetoric, and all those firms that do not belong to industry associations with high website sustainability are coded ‘0.’ Values of ‘0’ for High Sustainability Rhetoric therefore include not only firms that belong to industry associations with low and medium website sustainability, but also firms that do not belong to industry associations. The same is true for all the other industry association variables: Medium Sustainability Rhetoric, Low Sustainability Rhetoric, Sustainability Committee, Large Association, Medium Association, and Small Association. This means that 3M is coded for both Large Sustainability Rhetoric and Medium Sustainability Rhetoric, for example.

Dependent Variables

Planned Emissions and Fugitive Emissions, which comprised the two dependent variables in chapter 3, are used again here as a measure of firm sustainability. Planned Emissions comprise all releases of toxic chemicals that have been planned through the addition of formal mechanisms to remove the emissions from the workspace like ducts, stacks, sluices, pails, etc. Fugitive Emissions are releases of toxic chemicals that are released in other, unplanned ways, and include spills, evaporation, fires, and accidents. Both Planned and Fugitive Emissions are level 1 variables and are pooled, that is, the weights of the chemicals are added up into one figure for all emissions for a facility for 2016-2017. Both Planned and Fugitive Emissions are logged due to the extreme right skew. A fuller description can be found in Chapter 3.

Control Variables

A new set of controls is introduced.

Industry Association Size measures the number of member firms that belonged to an industry association according to member lists given on the industry association websites in 2016-2017. Because many firms are cross-nested (members of multiple industry associations) this measure, like several other measures in this study, has been broken down into three different dummy variables, Large Industry Association and Medium Industry Association, and Small Industry Association. The breaks were established by sorting the associations by size of membership, then dividing them into three nearly equal groups. For more information on industry association size, see Appendix 1.

Large Industry Association is a dummy variable that assigns '1' to a firm that is the member of a large industry association, and '0' otherwise. Large industry associations have more than 145 member firms.

Medium Industry Association is a dummy variable that assigns '1' to a firm that is the member of a medium-sized industry association, and '0' otherwise. Medium industry associations have between 50 and 123 member firms.

Table 4.2, Frequencies and Percentages of Firms Belonging to Industry Association Dummies

Dummy Variable	'1' Frequency	'1' percentage
Sustainability Committee	192	18.71%
Low Sustainability Website	106	10.33%
Med. Sustainability Website	209	20.37%
High Sustainability Website	98	9.55%
Small Industry Association	64	6.24%
Med. Industry Association	107	10.43%
Large Industry Association	250	24.37%

Small Industry Association is a dummy variable that assigns '1' to a firm that is the member of a small industry association, and '0' otherwise. Small industry associations have fewer than 50 member firms.

See Table 4.2 for the frequencies and percentages of firms belonging to these industry association variables.

Firm and facility level controls include the variables used in Chapter 3: High Credit Risk Firms, Firm Revenue, Subsidiary Layers, Facility Employees, Public, Small Business, and NAICS code. Short descriptions of these variables are offered here. For more detailed information, please see Chapter 3.

Firm Revenue (Level 2) is a continuous variable, the amount of money made by the firm in 2016, and as such is a measure of wealth and size. Firm Revenue is logged due to the extreme right skew.

Subsidiary Layers (Level 2) is a continuous variable that measures how many subsidiary layers there are between the topmost owning firm and the facility. It is essentially a measure of peakedness of the firm.

Facility Employees (Level 1), a continuous variable, is a count of the number of full-time employees working at the facility, a measure of size is logged due to extreme right skew. Facility employees is also included as quadratic and cubic functions.

Public (Level 2) is a dummy variable which is '1' if any part of the firm is publicly-owned and '0' otherwise.

Small Business (Level 2) is a dummy variable which is '1' if the firm has 2 or fewer facilities and no more than 2 organizational levels (facility and firm) and '0' otherwise.

North American Industry Classification System (NAICS) is a categorical variable that represents the classification system established by the Office of Management and Budget that categorizes firms based on business product. Use of this variable will help control for technological differences between the plastics subfields.

6. Analysis

Data and Sample

The data were assembled by combining two datasets, the Toxics Release Inventory (TRI) which is collected and maintained by the US EPA and financial data from Dun & Bradstreet Hoovers (D&B Hoovers) dataset. Level 1 variables come from the TRI, and level 2 variables come from D&B Hoovers. For a more extensive discussion of this data, please see Chapter 3.

The firms studied include all U.S. plastics firms that reported data to the TRI and for which data were available in Hoovers in 2016. Plastics firms are indicated by primary NAICS number as either 326100-326199 (resin producers) or in one of several other primarily plastics manufacturing areas. For a more detailed discussion of the selection process, please see chapter 3.

The total of 48 industry associations studied here were selected by consultation in the Encyclopedia of Associations (*Encyclopedia of Associations: National Organizations* 2016) and assiduous Internet searching. Of these, three were dropped from the analysis because they did not make membership lists publicly available,[29] and three were not included in regressions because no firm in the sample belonged to them,[30] leaving a total of 42 industry associations for the regressions and other analyses.

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[29] The International Bottled Water Association, Plastic Lumber Trade Association, and Polyurethane Foam Association do not make their membership publicly available. The PIA/SPI does not make its membership list available, however a list of committee members was provided by the PIA which I am very grateful for.

[30] No firm in this sample belonged to the Resilient Floor Covering Institute, the Vinyl Manufacturers Association, or the American Mold Builders Association.

Methodology

As in Chapter 3, multilevel modelling was employed – for more information, please see the relevant sections of Chapter 3. The original intent was to pool chemicals and make the resulting variable a level 1 characteristic of the facilities, nested in firms, then add the industry associations as level 3, however it became clear that many firms belong to more than one industry association, which would have created crossed nests. A simple response to this situation was to retain the chapter 3 nesting structure: facilities level 1, and firms level 2 and to include industry association variables of interest as dummy variables, coding '1' for presence of the characteristic and '0' for lack of the characteristic. In this way, a firm that belongs to both a small and a large industry association can have both memberships included appropriately. In future iterations of this project, other methods of analysis will be investigated for a better analytical option.

Seven models were run each for Planned Emissions and Fugitive Emissions. The initial model is the null model. Next comes the variables of interest in specific arrangements designed to examine the effects of the various industry association variables on the membership variable. In Model 2 Member appears by itself to establish a baseline value, and in Model 3 Member appears with Sustainability Committee. In Model 4 Member appears with the set of variables, High Sustainability Rhetoric, Medium Sustainability Rhetoric, Low Sustainability Rhetoric, and in Model 5, Member appears with Large, Medium and Small Associations. In Model 6 I put all the industry association variables together, and finally, financial controls from Chapter 3 are added in for Model 7. Basically, in Models 2-6 we can explore the effects of the various industry association variables, or moderators on the membership variable, which may allow some observations on the nature of industry association membership. In Model 7 I include all the variables used in this project to examine whether the industry association variables continue to demonstrate their effects when finance and structure are controlled for. Abbreviated tables of the significant effects appear below (see Tables 4.3 and 4.4), and the full models appear in the Appendix (A4 and A5).

Results

In discussing the results, I will begin with Planned Emissions, move to Fugitive Emissions, and then end with some observations on the comparison of the two dependent variables.

Planned Emissions

For Planned Emissions, Member is negative and insignificant in Model 2, meaning that member firms have lower planned emission on average (as predicted in Hypothesis 5). However, this difference is not statistically different. In Model 3, however, the mean difference between members and non-members increases and becomes significant because this coefficient now captures Planned Emissions for all member firms that do not have Sustainability Committees. Conversely, the sustainability committee covariate captures the mean difference in Planned Emissions between member firms with and without a sustainability committee, and suggests that the former have higher Planned Emissions than the latter. Indeed, member firms with sustainability committees have slightly higher planned emissions than non-member firms, indicated by the sum of member and sustainability committee. However, this difference is not likely significant.

In Model 3, I include the three sustainability rhetoric variables. The sustainability rhetoric variables are all significant, and fall along the continuum of coefficients predicted by Hypotheses

Table 4.3 Multilevel Regression with Planned Emissions as Dependent Variable, Industry Association Variables, Short Table

	(1) Planned Emissions	(2) Planned Emissions	(3) Planned Emissions	(4) Planned Emissions	(5) Planned Emissions	(6) Planned Emissions	(7) Planned Emissions
Member		-0.236	-1.031***	0.314	0.462	1.408***	2.553***
		(0.222)	(0.358)	(0.417)	(0.488)	(0.530)	(0.522)
Sustainability Committee			1.036***			5.710***	4.505***
			(0.365)			(0.729)	(0.722)
High Sustainability Rhetoric				-0.982***		-2.742***	-2.634***
				(0.381)		(0.554)	(0.550)
Medium Sustainability Rhetoric				-0.702**		-1.532***	-1.597***
				(0.345)		(0.418)	(0.435)
Low Sustainability Rhetoric				2.034***		2.182***	1.019**
				(0.386)		(0.423)	(0.429)
Members of Large Associations					-0.140	-3.564***	-3.558***
					(0.404)	(0.748)	(0.731)
Members of Medium Associations					-0.882**	-1.087***	-1.242***
					(0.362)	(0.393)	(0.409)
Members of Small Associations					0.469	-0.344	0.527
					(0.362)	(0.430)	(0.485)
High Credit Risk Firms							0.725**
							(0.331)
Constant	3.234***	3.308***	3.355***	3.167***	3.193***	3.102***	5.466***
	(0.262)	(0.272)	(0.272)	(0.277)	(0.275)	(0.275)	(2.078)
Level 2 SD "Between" (cons)	7.974***	7.993***	7.962***	7.999***	7.961***	7.879***	7.492***
	(0.197)	(0.198)	(0.198)	(0.199)	(0.198)	(0.196)	(0.188)
Level 1 SD "Within"	3.505***	3.503***	3.503***	3.491***	3.503***	3.478***	3.229***
	(0.035)	(0.035)	(0.035)	(0.035)	(0.035)	(0.035)	(0.032)
Obs.	6,044	6,044	6,044	6,044	6,044	6,044	6,044
AIC	35,036	35,036	35,030	35,008	35,036	34,950	34,143
BIC	35,056	35,063	35,064	35,055	35,083	35,024	34,371
R^2 Level 1		-0.004	0.003	-0.004	0.003	0.023	0.123
R^2 Level 2		-0.004	0.003	-0.005	0.003	0.023	0.121

Standard errors are in parentheses; *** $p<0.01$, ** $p<0.05$, * $p<0.1$. R^2 is based on Snijders & Bosker (2012). For defense of negative R^2 see Snijders & Bosker (2012). For complete table, please see Appendix.

Table 4.4, Multilevel Regression with Fugitive Emissions as Dependent Variable, Industry Association Variables, Short Models

	(1) Fugitive Emissions	(2) Fugitive Emissions	(3) Fugitive Emissions	(4) Fugitive Emissions	(5) Fugitive Emissions	(6) Fugitive Emissions	(7) Fugitive Emissions
Member		-0.332	-1.962***	-1.860***	-1.658***	-1.409**	-0.755
		(0.252)	(0.405)	(0.473)	(0.553)	(0.604)	(0.599)
Sustainability Committee			2.129***			0.952	-0.011
			(0.415)			(0.818)	(0.815)
High Sustainability Rhetoric				1.784***		0.838	0.802
				(0.431)		(0.624)	(0.626)
Medium Sustainability Rhetoric				0.392		-0.474	-0.002
				(0.393)		(0.477)	(0.501)
Low Sustainability Rhetoric				0.223		0.223	-0.314
				(0.438)		(0.482)	(0.492)
Members of Large Associations					2.619***	1.334	1.387*
					(0.461)	(0.846)	(0.834)
Members of Medium Associations					-1.163***	-1.673***	-1.501***
					(0.409)	(0.450)	(0.470)
Members of Small Associations					-0.522	-0.392	-0.838
					(0.413)	(0.494)	(0.556)
High Credit Risk Firms							0.190
							(0.383)
Constant	0.342	0.447	0.540*	0.627**	0.365	0.462	10.857***
	(0.266)	(0.279)	(0.280)	(0.284)	(0.285)	(0.288)	(2.331)
Level 2 SD "Between" (cons)	7.968***	7.985***	7.998***	7.999***	8.060***	8.063***	7.705***
	(0.203)	(0.204)	(0.204)	(0.205)	(0.205)	(0.206)	(0.201)
Level 1 SD "Within"	4.084***	4.082***	4.070***	4.074***	4.058***	4.055***	3.823***
	(0.041)	(0.041)	(0.041)	(0.0041)	(0.041)	(0.041)	(0.038)
Obs.	6,044	6,044	6,044	6,044	6,044	6,044	6,044
AIC	36,604	36,604	36,580	36,593	36,567	36,567	35,925
BIC	36,624	36,631	36,613	36,640	36,614	36,641	36,153
R^2 Level 1		-0.003	-0.005	-0.005	-0.016	-0.016	0.077
R^2 Level 2		-0.004	-0.006	-0.006	-0.019	-0.019	0.073

*Standard errors are in parentheses; *** $p<0.01$, ** $p<0.05$, * $p<0.1$; for complete table, please see Appendix. R^2 is based on Snijders & Bosker (2012). For defense of negative R^2 see Snijders & Bosker (2012).*

1-3, but in addition, low-sustainability rhetoric appears to *increase* planned emissions relative to both non-member firms and member firms with high and medium sustainability rhetoric.

Finally, in Model 5 I moderate the membership dummy with the size of industry association. In this case, Member stays positive and is not significant.[31] Firms in medium-sized associations produce fewer planned emissions than both non-member firms (add member to medium), as well as members of large and small associations. Indeed, firms in these latter two categories appear to produce greater planned emissions than non-member firms on average, though I have not tested the null hypothesis that this difference is different from zero.

Model 6 contains all industry association variables and Model 7 also contains the financial variables from Chapter 3. Through these models it is evident that the average effect of the presence of a Sustainability Committee is associated with a relatively large increase in the release of Planned Emissions. Additionally, firms that belong to industry associations with high and medium sustainability rhetoric produce fewer Planned Emissions than non-member firms and member firms with low-sustainability rhetoric. Firm members of Large and Medium Associations produce significantly fewer Planned Emissions on average as demonstrated in Models 6 and 7.

Finally, in looking at Model 7, which adds the financial, size, and structural variables from Chapter 3, the industry association variables continue to be significant and only adjust slightly in terms of value. The financial, size and structural variables also behave much the same as they did in Chapter 3, except that the coefficient for High Credit Risk Firms increases in size and significance (from .551* to .725**). In an unreported regression, this difference actually emerges when Firm Credit Risk appears with Medium Sustainability Rhetoric, which functions as

[31] Member here is the average of the firms that belong to industry associations that were not rated by size, and is therefore a very small group.

a suppressor variable here. How Credit Risk, which implies information about firm financial stability and debt repayment, is connected to industry association membership is an intriguing question to be answered another day.

We can combine the various industry association dummies to get a sense of which member firms produce the highest Planned toxic Emissions, and which produce the least. For example, firms belonging to large associations with high sustainability rhetoric and no sustainability committee, on average, produce the least emissions (Member 2.553 + High Sustainability Rhetoric -2.634 + Large Association -3.558 = -3.639). On the other hand, firms belonging to small industry associations with sustainability committees and low website rhetoric are associated with the largest Planned Emissions on average (Member 2.553 + Sustainability Committee 4.505 + Low Sustainability Rhetoric 1.019 + Small Association 0.527 = 8.604).

Fugitive Emissions

For Fugitive Emissions, the story is different. Whereas Planned Emissions comprise any toxic emission which has a preordained route for removal from the work space, including chimneys, sluices, vents, etc., Fugitive Emissions include all unplanned emissions, stemming from accidents and unplanned events, for example, spillage, evaporation, and explosions. Involvement in industry associations does not appear to have as much effect on Fugitive Emissions as it does on Planned Emissions, at least as represented by these variables. Starting with Model 2, the Member coefficient is negative and nonsignificant, however it increases and remains significant from Model 3 to Model 6, which supports Hypothesis 1. When Sustainability Committee is added, the negative and significant Member variable represents all firms that belong to industry associations without a Sustainability Committee. Firms belonging to industry associations with sustainability committees have significantly higher Fugitive Emissions than those without sustainability committees, on average, and also appear to have higher Fugitive Emissions than non-member firms (-1.962 + 2.129). Here again, Hypothesis 1, which predicted that firms belonging to industry associations with sustainability committees would have lower toxic emissions, is unsupported.

When Member is joined by the sustainability rhetoric variables in Model 4, it remains negative and significant, whereas firms belonging to industry associations with High Sustainability Rhetoric are significant and positive, Medium Sustainability Rhetoric is nonsignificant and positive, and Low Sustainability Rhetoric is nonsignificant and positive. Interestingly, the previous pattern for Planned Emissions is inverted here, with High Sustainability Rhetoric firms having the *highest* Fugitive Emissions, on average, and this pattern continues in model 6 and 7, although the coefficient for High Sustainability Rhetoric is not significant after Model 4.

In Model 5 we add the association size variables to Member, and see a different pattern. While Member stays negative and significant, the Large and Medium Association coefficients are also significant, with firm members of large industry associations emitting the most Fugitive Emissions on average, and firm members of medium industry associations the *least*. This pattern continues in Model 6 and Model 7, with Medium Associations remaining significant and negative, the lowest of the three scores in each model.

In Model 6, only Member and Medium Association are significant, however at this point the Member variable is not very meaningful as it represents only the member firms that have a "0" for every other dummy in this model, a very small group. In terms of the association variables, only Members of Medium Associations are significant for the fully loaded model, Model 7. It therefore appears that these particular industry association variables, with the exception of Sustainability Committee and Medium Associations, have little effect on firm Fugitive Emissions.

As in the Chapter 3 models, it is obvious that the variables selected are not as closely associated with Fugitive Emissions as they are with Planned Emissions. In the Chapter 4 models, not only are there fewer significant variables, but there are more sign changes and large differences in value between models. Indeed, model fit measures are also poorer overall, with a more than 1,700-point difference between the AIC and BIC of Planned Emissions versus Fugitive Emissions. The Fugitive Emissions level 1 and level 2 R^2 (7.7/7.3) is also very low in comparison to the Planned Emissions with a level 1 and 2 R^2 of 12. I conclude that when trying to explain Fugitive Emissions in the plastics industry, other variables should be used.

Analysis and Discussion

Based on this analysis, the first impression of industry association relationship to firm sustainability, is of complexity. We find two examples of industry association sustainability behavior, sustainability rhetoric messaging and sustainability committee, resulting in very different findings: one implies that industry associations do help firms diminish planned emissions (High Sustainability Rhetoric) and the other implies that industry associations do not do so (Sustainability Committee). Given that there are many different types of industry associations in the plastics industry, it may not be very surprising to find that these organizations appear to affect sustainability from different directions.

Before we plunge into these details, however, perhaps the most important point here is to step back and consider that these data have presented evidence that membership in industry associations can lead to effects on firm sustainability behavior. An industry association, an organization of organizations, may appear to be a somewhat abstract concept, however, this is likely only because most people do not spend a great deal of time thinking about them. In fact, industry associations have effects in the world, and not just on political processes. These findings lend credence to the idea of industry association as knowledge community or collectivity, a function of their knowledge-conserving services. It also supports an Institutional perspective that the choices people make based on tradition, networks, and relationships are very important, even in the midst of the highly competitive capitalist system.

Sustainability committees are correlated with higher member firm emissions in 2016, not lower and if one is making the assumption that a sustainability committee exists because firms are actively engaged in sustainability, then this is a surprising finding. First, it should be kept in mind that the classification, "sustainability committee" refers to a variety of committees, including Recycling Committees and a Bio-composites Committee, so the establishment of a sustainability committee may not, ipso facto, lead to lower toxic emissions. It may be, on the other hand, that firms form sustainability committees in the face of increased pressure to perform in more sustainable ways (for example, government penalties for environmental harms), in which case, the correlation between sustainability committee and increased planned emissions may be a function of firm interest in improving environmental records rather than a signal of success. It could also be that ceremonial compliance, or greenwashing, is operating through the establishment of a sustainability committee, a finding which would be supported by Neo-Institutional theory. There is certainly a great deal of evidence of this sort of behavior in the literature. Vidovic et al. (2019) and King & Lennox (2000), for example, found that membership in the Responsible Care program of the ACC had no effect on emissions and may actually be associated with higher rates of toxic releases. Brouhle et al. (2009) found that members of a metal finisher industry association actually released more emissions than non-members. This question could be further investigated by examining planned emissions rates before and after the establishment of sustainability committees, and by searching for recent findings against member firm environmental performance.

On the other hand, firms belonging to industry associations with larger amounts of website sustainability information were associated with lower planned emissions, as expected. Large amounts of website information indicates that there are at least 15 full pages of sustainability text on the website: the adjusted minimum score for high Sustainability Rhetoric is 79.5, and the highest page score is 5: 79.5/5 = 15.9. High sustainability rhetoric websites therefore include between 15.9 – 42.6 pages on sustainability topics on average. This indicates a great deal of effort over time to relay sustainability information and solutions to the public and member firms. It may be that the effort and planning of producing a really large amount of sustainability website rhetoric reflects ongoing environmental concern which is also reflected in member firm Planned Emissions. After all, the manpower hours reflected in developing such large information troves are a real cost to associations, particularly small associations. One next step, therefore, may be to investigate whether the size of the association is related to the amount of sustainability messaging.

While there appears to be some association between size of association and sustainability rhetoric, the question of why association size would affect member Planned Emissions is a very interesting one. Perhaps the size of association is linked to the presence of large, prestigious firms, or brands, which have been shown to be more interested in sustainability than other, less visible firms. Industry associations generally charge for membership by size of firm, and very visible, wealthy firms tend to play an outsized role in associations, not only because of the larger numbers of employee members, but also because large firms tend to hold seats on boards of directors. Early evidence in this study shows that larger firms tend to belong to the two largest associations, (the PIA/SPI and the ACC). A next step would be investigate whether large associations tend to have more large firms (and especially brands) and whether smaller associations tend to have fewer large firms and brands.

This dissertation is not a claim that industry associations in and of themselves foster lower emissions or higher emissions: we have seen evidence of both conditions. It is likely, however, that an industry association, given agreement of the membership and buy-in from the staff, can influence emissions. From a Neo-Institutional perspective, we might be surprised that any industry associations were associated with lower emissions at all, because according to this view, organizations may appear to join with exogenous forces that demand change based on legitimacy, but in reality, maintain loose coupling between ceremonial compliance and actual operations. Resource Dependence also similarly provides a great deal of information on how firms will deal with unwanted legitimacy demands without changing operations (Pfeffer and Salancik 2003).

I suspect, however, that insofar as these effects are intentional, they are likely related to institutionalized ways of thinking about the proper use of toxic chemicals by members of the industry association. An industry association that promotes the use of nontoxic or less toxic alternatives, or work processes that use fewer toxic chemicals, or even an industry association that promotes careful, measured reporting, could lead to diminished Planned Emissions on the part of the membership. It is hard to create a conjecture where any industry association would promote the inappropriate use of toxic chemicals -- after all, employees would be the first harmed by such practices -- however one could imagine an industry association that shows little care for use of toxic chemicals, rarely communicates about best practices in toxic chemical reduction, and does not work with membership to develop careful reporting practices. Such an industry association might be more likely to have a lower amount of website sustainability materials and perhaps have member firms that release more Planned Emissions.

This analysis supports the effects of industry associations on member firms, and that is probably the most significant finding, however, it does not uniformly support the Neo-Institutionalist perspective, which would have predicted that firms would isomorphically reflect ceremonial compliance and loose coupling when presented with demands to adopt sustainability measures. There may be plenty of ceremonial compliance and loose coupling in sample plastics firms, but there also appears to be genuine compliance as well.

These are hopeful findings for pro-sustainability advocates. Variables associated with institutional processes (social decisions to join certain industry associations) can be associated with the diminution of emissions. This means that social processes can result in pro-sustainability change – a central Ecological Modernization argument. Sustainability-oriented organizational change may be possible through the influence of industry associations, perhaps because by nature industry associations tend to engage in change processes that are formulated and promulgated by membership. Based on this first look at the data it appears that the influence of peers can result in diminished toxic emissions rather than ever-increasing loads. This is particularly important because, as has been noted repeatedly in *The Plastics News*, younger plastics firm employees generally show a much greater interest in sustainability than their elders. Other more nuanced analytical procedures will surely bring opportunities to develop the validity and reliability of these observations leading to a better ability to say whether the results of this dissertation will stand up, however, a little light might be shining for a brighter future. That can be enough to go on for now.

Chapter 5, Conclusion

This project has been an exploration of sustainability in plastics firms and their industry associations and what it can reveal about organizations. Using toxic emissions as a proxy for sustainability, the financial and structural data of plastics firms, and characteristics of related industry associations have been explored. Evidence indicates that both types of variables were significantly associated with increases and decreases of Planned and Fugitive Toxic Emissions for sample plastics firms in 2016. This indicates that not only are some typical financial and structural characteristics of firms important for toxic emissions, but also the social choice of firm owners and managers to belong to an industry association or not.

This concluding chapter will review the results of the project and discuss some of the limitations of the work and related future projects.

Results of the Project

Starting in Chapter 2, we reviewed two important sustainability theories and the organizational theories that shed light on them. First came the Treadmill of Production (TP), which characterizes industrial production as a sort of unstoppable resource-consuming machine that will leave Planet Earth a bleak, resourceless hot house unable to sustain human life. The Treadmill is characterized by firms that must maintain production ceaselessly under the force of the capitalist system of resource and human exploitation.

Resource Dependence, an important organizational theory shed light on TP by highlighting the importance of organizational survival, which fuels the Treadmill. Resource Dependence also highlights the tendency of firms to avoid interdependencies, or arrangements where the firm becomes subject to another entity for resources and therefore loses flexibility. It is predicted that avoidance of interdependencies will lead firms to avoid sustainability measures, except in the environment of strong government regulations. Between the drive to survive and avoid interdependencies, Resource Dependence would appear to line up with TP under most conditions.

Neo-Institutionalism, another important organizational theory, has a more ambiguous relationship to the TP. On one hand, Neo-Institutionalism details how isomorphic change occurs, so if sustainability were to become a legitimating factor, it could be adopted by firms and implemented. On the other hand, Neo-Institutionalism also presents a view of firms which adopt a public-facing position of compliance to external demands while maintaining loose coupling with internal production processes which likely operate uninterrupted. In the sustainability space, this kind of operation, often called “green washing,” would preclude the organizational change that sustainability calls for and ultimately lead to TP-style devastation.

Next came Ecological Modernization, which sees firms as institutional in nature, and therefore capable of operating in terms of the aggregated views of the people who own, manage, and work in them. To this way of thinking, the bottom line is somewhat less tyrannical, and social concerns, like an interest in sustainability, could theoretically become legitimating factors that could cause changes to firm operations such that global demise is not inevitable.

All three organizational theories would only agree with the Ecological Modernization scenario if the demand for sustainability created a forceful legitimacy requirement, one that engaged government into the implementation of regulations, yet even under these conditions, firms will still attempt to perform ceremonial compliance in some number of cases per Meyer & Rowan (1977). Unfortunately, it is unclear whether the public can present a strong enough demand to impel government to truly engage in not only the creation, but the implementation of strong environmental law.

In Chapter 3 we found that size and wealth of a facility and a firm are not necessarily the unmitigated drivers of toxic emissions that one might think, although they are definitely factors. For example, at the firm level, while Revenue as a main effect is highly significant in Model 1, by Model 5 it is only marginally significant in an unreported regression. As part of an interaction with Subsidiary Levels, on the other hand, we find that Planned and Fugitive toxic Emissions increase as a factor of revenue by subsidiary level. In other words, larger firms with more subsidiary levels release more toxic emissions at every level. It is not only size, but structure that contribute to the effect.

Similarly, the cubic function of Facility Employees demonstrates that size of facility is differentially associated with levels of emissions. For very small organizations of less than about 5 employees for Planned Emissions (and 7 employees for Fugitive Emissions), increased employees lead to decreased emissions. Yet emissions grow gradually with higher numbers of employees until 401 for Planned Emissions, and after that point, Planned toxic Emissions decreases with larger numbers of facility employees. The fact that the largest facilities are associated with decreased emissions may indicate that after a certain point, employees are superfluous to the production process – perhaps they are actually associated with a headquarters, or doing administrative work. Or, if larger facilities are associated with larger firms, it may be that increased resources allow larger facilities to engage in more sustainability operations. More work is needed.

Indeed, the variable most associated with resource availability, Firm Credit Risk, is positive and not significant until Model 5 in the Chapter 3 analysis, however it does not become highly significant after all variables are added in the Chapter 4 analysis. Clearly resources are important, but issues of structure and association are also important when considering toxic emissions and sustainability.

In Chapter 4, the analysis was of industry association membership and some sustainability characteristics of industry associations. The hypotheses were designed to test whether institutional orders created by industry associations were associated with Planned and Fugitive toxic Emissions. The provisional results were mixed: membership in industry associations with sustainability committees was associated with increased emissions, while membership in industry associations that appear to try to communicate about sustainability (High Sustainability Rhetoric) were associated with lower levels of planned toxic emissions.

Member firms of industry associations that have sustainability committees were associated with increased emissions, although to find the actual reason behind this result, further investigation would be required. Such committees are often formed around recycling, so their connection to emissions, is somewhat mysterious. The finding that increased Sustainability Rhetoric text is associated with lower firm emissions may be a straightforward validation that industry associations as Knowledge Collectivities are associated with member firm performance. Firm members of large industry associations also had lower emissions, however, and so it will be important to check on the correlation between large industry associations and industry associations with high sustainability websites.

In a sense, any significant result that indicated that industry association influence was felt at firm level data was a significant finding because no particular level of influence of industry associations on firms has been established -- after all, firms do not have the same relationship to industry associations that classrooms have to schools.

Limitations of the Study

This study has several limitations. As discussed earlier, it is not a random sample of plastics firms and so although it covers a wider swath of types of US plastics firms than other studies have, generalizability to the entire population is not certain. At the same time, it is not currently possible to gather a random sample of US plastics firms and get financial information, so studies like this are likely the best that can be done with the data available for sampling.

Another limitation is that this study is cross-sectional, and therefore many questions are left outstanding. A longitudinal study would much more effectively disentangle the reciprocal causality problem around industry association membership, for example. If we could acquire the dates firms joined various associations, we could analyze pre and post membership toxic emissions to ascertain change over time. Longitudinal modelling would also be useful to ascertain whether the effects seen in this study are unique to 2016, or whether they occur in similar proportions across years, thereby providing better evidence of underlying social mechanisms than a cross sectional study can.

Future Research

There are many paths that can be taken with this work, and many recommendations have been made. Certainly, the analyses can be strengthened if they could be made longitudinal, and there are other important variables that could be added to the analyses, for example, Source Reduction data from the TRI. There are always things that can be done to evolve a work, and the core of this dissertation would seem to provide a solid foundation for further development.

It has been suggested, and I am currently planning on, developing these materials into a book which can be adapted to both scholarly and popular interest. Plastics always seems to be an important topic of interest due to ongoing issues of nondecomposabilty, litter, and occasional cases of chemical harms to people, yet little is known of the industry itself. There have been a few excellent books, both scholarly and popular, on plastics, for example, Fenichell's *Plastic: The Making of a Synthetic Century* (1996), Miekle's *American Plastic: A Cultural History* (1997), and Freinkel's *Plastic: A Toxic Love Story* (2011). With the exception of some parts of Meikle, however, little has been written about the plastics industry per se.

There would seem to be space for a book that would pull together what is known about the plastics industry with a strong environmental emphasis, and informed discussion and analysis of plastics industry associations. There is much opinion online that criticizes plastics: there are even people who attempt to live completely without plastic and preach the benefit of this. While there is a great deal of material put out by industry associations extolling the virtues of plastics, however there may be space for a book that takes an even-handed look at the plastics industry and industry associations with the goal of understanding them better: the good with the bad. After all, plastics is indispensable to the modern world, and it also potentially presents great environmental harm. The way to square that circle is likely to get to know plastics producers better, so that constructive solutions can be created and implemented for all stakeholders. At the same time, studies are urgently needed of industry associations in order to help policy makers as well as ordinary citizens recognize the ways these peak organizations tend to work for their clients (plastics, oil, natural gas, etc.), and the kind of influence they can wield. For example, current efforts to prevent cities and counties from banning fracking and plastic bags, and promoting the installation of electric home heating systems all stem from industry association activity to preserve access to resources and sales. Such tactics cannot easily be resisted unless people and policy makers understand them.

The book as planned would have two dimensions. Chapters would be written toward the layman, emphasizing the narrative aspect of the content, however, these would be heavily footnoted with reference to scholarly materials. Appendices would be included for those interested in the research basis of the work, and materials based on this dissertation, as well as other original research, would be included here. It is hoped that this combination of stories and data will result in a book would reach a wide audience, form the basis of new government policy, and improve the average person’s understanding of plastics and the organizational environment.

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Appendix

Table A1 Multilevel Regression, Planned Emissions as the Dependent Variable, Financial Variables, Complete Models

	(1 Null) Planned Emissions	(2) Planned Emissions	(3) Planned Emissions	(4) Planned Emissions	(5) Planned Emissions
High Credit Risk Firms		0.168	0.155	0.302	0.551*
		(0.324)	(0.324)	(0.320)	(0.311)
Firm Revenue (log)		0.168**	0.097	0.023	0.062
		(0.066)	(0.078)	(0.078)	(0.093)
Subsidiary Layers		0.037	-1.812*	-1.407	-2.663**
		(0.089)	(1.093)	(1.083)	(1.065)
Facility Employees (log)		0.121**	0.120**	-1.381***	-0.634**
		(0.047)	(0.047)	(0.332)	(0.321)
Firm Revenue X Subsidiary Layer			0.080*	0.064	0.113**
			(0.047)	(0.047)	(0.046)
Facility Employees X Facility Employees				0.524***	0.356***
				(0.073)	(0.070)
Facility Employees X Facility Employees X Facility Employees				-0.044***	-0.033***
				(0.005)	(0.005)
Public					-2.031***
					(0.464)
Small Business					-1.494***
					(0.423)
NAICS Codes Comparison Group: 325211 Plastics Material & Resin Man.					
325212 Synthetic Rubber Manufacturing					1.582***
					(0.562)
325220 Artificial and Synthetic Fibers and Filaments Man.					0.155
					(0.511)
325510 Paint and Coating Manufacturing					-2.396***
					(0.257)
325991 Custom Compounding of Purchased Resins					-6.761***
					(0.390)
326111 Plastic Bag and Pouch Manufacturing					7.020
					(7.962)
326113 Unlaminated Plastics Film and Sheet (ex.Pkg) Man.					-1.530***
					(0.425)
326121 Unlaminated Plastics Profile Shape Manufacturing					1.369
					(1.348)
326122 Plastics Pipe and Pipe Fitting Manufacturing					-8.574***
					(0.778)
326130 Laminated Plastics Plate, Sheet (ex.Pkg) & Shape Man.					-1.977***
					(0.645)
326140 Polystyrene Foam Product Manufacturing					-10.707***
					(1.207)
326150 Urethane and Other Foam Product Manufacturing					-7.097***
					(0.522)
326160 Plastics Bottle Manufacturing					-11.329***
					(2.182)
326191 Plastics Plumbing Fixture Manufacturing					2.422***
					(0.934)
326199 All Other Plastics Product Manufacturing					-1.886***

	(1 Null) Planned Emissions	(2) Planned Emissions	(3) Planned Emissions	(4) Planned Emissions	(5) Planned Emissions
					(0.371)
Constant	3.234	-0.308	1.552	3.148**	5.900***
	(0.262)	(1.103)	(1.556)	(1.570)	(1.996)
Lev 2 SD "Between" C	7.974***	7.900***	7.886***	7.890***	7.607***
	(0.197)	(0.196)	(0.196)	(0.195)	(0.190)
Lev 1 SD "Within"	3.505***	3.504***	3.504***	3.445***	3.245***
	(0.035)	(0.035)	(0.035)	(0.034)	(0.0326)
Observations	6,044	6,044	6,044	6,044	6,044
AIC	35,036	35,023	35,022	34,853	34,205
BIC	35,056	35,070	35.076	34,920	34,380
R^2 Level 1		0.016	0.019	0.023	0.099
R^2 Level 2		0.017	0.020	0.021	0.090

*Standard errors are in parentheses; *** $p<0.01$, ** $p<0.05$, * $p<0.1$; R^2 is based on Snijders & Bosker (2012).*

Table A2 Multilevel Regression, Fugitive Emissions as the Dependent Variable, Financial Variables, Complete Models

	(1 Null) Fugitive Emissions	(2) Fugitive Emissions	(3) Fugitive Emissions	(4) Fugitive Emissions	(5) Fugitive Emissions
High Credit Risk Firms		-0.090	-0.127	-0.145	-0.338
		(0.371)	(0.371)	(0.371)	(0.360)
Firm Revenue (log)		0.083	-0.095	-0.100	-0.131
		(0.073)	(0.087)	(0.087)	(0.104)
Subsidiary Layers		0.223**	-4.309***	-4.044***	-4.552***
		(0.102)	(1.203)	(1.202)	(1.192)
Facility Employees (log)		0.089	0.087	-1.639***	-1.377***
		(0.055)	(0.055)	(0.388)	(0.375)
Firm Revenue X Subsidiary Layer			0.196***	0.185***	0.203***
			(0.052)	(0.052)	(0.051)
Facility Employees X Facility Employees				0.436***	0.384***
				(0.085)	(0.082)
Facility Employees X Facility Employees X Facility Employees				-0.030***	-0.027***
				(0.006)	(0.005)
Public					-0.904*
					(0.524)
Small Business					-1.056**
					(0.484)
NAICS Codes Comparison Group: 325211 Plastics Material & Resin Man.					
325212 Synthetic Rubber Manufacturing					-1.899***
					(0.655)
325220 Artificial and Synthetic Fibers and Filaments Man.					1.078*
					(0.602)
325510 Paint and Coating Manufacturing					-1.443***
					(0.298)
325991 Custom Compounding of Purchased Resins					-8.946***
					(0.450)
326111 Plastic Bag and Pouch Manufacturing					-14.955*
					(8.121)
326113 Unlaminated Plastics Film and Sheet (ex.Pkg) Man.					-2.120***
					(0.495)
326121 Unlaminated Plastics Profile Shape Manufacturing					-5.888***
					(1.474)
326122 Plastics Pipe and Pipe Fitting Manufacturing					-13.444***
					(0.897)
326130 Laminated Plastics Plate, Sheet (ex.Pkg) & Shape Man.					-4.283***
					(0.736)
326140 Polystyrene Foam Product Manufacturing					-13.004***
					(1.395)
326150 Urethane and Other Foam Product Manufacturing					-5.763***
					(0.590)
326160 Plastics Bottle Manufacturing					-2.629
					(2.539)
326191 Plastics Plumbing Fixture Manufacturing					-0.883

	(1 Null) Fugitive Emissions	(2) Fugitive Emissions	(3) Fugitive Emissions	(4) Fugitive Emissions	(5) Fugitive Emissions
					(0.995)
326199 All Other Plastics Product Manufacturing					-4.096***
					(0.419)
Constant	0.342	-1.908	2.701	4.451**	9.287***
	(0.266)	(1.208)	(1.715)	(1.753)	(2.238)
Level 2 SD "Between"	7.968***	7.916***	7.903***	7.903***	7.632***
	(0.203	(0.203)	(0.202)	(0.202)	(0.198)
Level 1 SD "Within"	4.084***	4.083***	4.078***	4.066***	3.842***
	(0.041)	(0.041)	(0.041)	(0.041)	(0.039)
Obs.	6,044	6,044	6,044	6,044	6,044
AIC	36,604	36,597	36,585	36,557	35,943
BIC	36,624	36,644	36,638	36,625	36,117
R^2 Level 1		0.010	0.013	0.015	0.089
R^2 Level 2		0.011	0.014	0.015	0.087

Standard errors are in parenthesis
**** p<0.01, ** p<0.05, * p<0.1*

Chapter 4 Rating Instrument

Data Collection, Industry Associations and Sustainability

1 IA per spreadsheet!

Name of IA:

URL:

Date:

1. Locations

Is sustainability mentioned on (0 to 5 each):

a. Homepage (primary level)

b. Header pages (secondary level: major
   divisions of the website)

c. Header drop down pages (tertiary level)

IF THERE ARE MULTIPLE PAGES, INSERT NEW LINES, ONE PER PAGE AND CODE.

2. Programs

Are there any of the following types of sustainability features (0-5 each)?

a. Classes for the members

b. Programs to help member firms be sustainable? ex. Responsible Care

c. Sustainability/recycling Committee

d. Awards

3. Official documents

Is sustainability mentioned in the following documents (0-5 each)?

a. About the IA

b. Organizational goals or objectives

c. Statement by board of directors

d. Formal sustainability position

4. Does sustainability appear anywhere
else on the site? (0-5 each)

5. Overall, how easy was it for you to find info on sustainability for the IA?
a. One click (1 or 0)
b. Two clicks (1 or 0)
c. Three clicks (1 or 0)

6. Overall, is the sustainability information on the site
directed toward consumers or firms? Code: 0 mostly
consumers; 1 mostly firms; 3 consumers and firms both,
about equally; 4 unclear intent.

7. Does the IA have a members only section?

8. Notes

Table A3 Plastics Industry Association Size

	# Industry Association Members	# Sample Facility Members*	Av. Firm Size (#Est.)
PETRA - PET Resin Association (30)	4	8	180
IPA - Institute for Polyacrylate Absorbents (47)	6	19	967
CLMA - Composite Lumber Manufacturers Association (28)	8	50	489
CFFA - Chemical Fabrics and Film Association (8)	9	9	138
FPTPI - Fiberglass Tank and Pipe Institute (40)	10	37	817
VI - Vinyl Institute (6)	12	60	399
VSI - Vinyl Siding Institute (13)	15	11	821
BPSA - The Bio-Process Systems Alliance (48)	16	10	279
SIRC - Styrene Information and Resource Center (26)	24	53	450
PMA - Polyurethane Manufacturers Association (32)	25	40	494
PSCI - Plastic Shipping Container Institute (31)	27	31	601
PVCPA - PVC Pipe Association (3)	41	30	769
AFMA - American Fiber Manufacturers Association (12)	43	35	370
PSTC - Pressure Sensitive Tape Council (44)	50	64	477
NAPCOR - The National Association for PET Container Resources (16)	51	18	254
Polyiso - Polyisocyanurate Insulation Manufacturers Association (27)	54	56	1,298
IMDA - In-Mold Decorating Association (14)	55	5	363
EPS-IA - The (polystyrene) EPS Industry Alliance Association (18)	64	35	731
TRFA - Thermoset Resin Formulators Association (35)	73	27	457
PPFA - Plastic Pipes and Fittings Association (5)	76	71	861
WPA - Western Plastics Association (23)	80	28	635
GPI - National Association of Graphic and Product Identification Manufacturers (41)	87	23	439
EA - The Electrocoat Association (46)	104	49	1,115
ASC - Adhesive and Sealant Council (39)	120	159	616
PMPA - Precision Machined Products Association (43)	120	2	141
CCAI - Chemical Coaters Association International (45)	121	62	2,095
PPI - Plastics Pipe Institute (24)	123	109	718
ARM - Association of Rotational Molders (19)	145	55	1,073
FPA - Flexible Packaging Association (21)	155	106	994
AIMCL - Association of Industrial Metallizers, Coaters and Laminators (38)	166	106	965
SPFA - Spray Polyurethane Foam Alliance (34)	174	27	1,498
FPI - Foodservice Packaging Institute (36)	178	66	1,255
ACC - American Chemistry Council (7)	192	279	796
ICMA - International Card Manufacturers Association (29)	200	25	1,213
IAPD - International Association of Plastics Distribution (11)	235	46	1,258
ANFI-INDA - Association of the Nonwoven Fabrics Industry (20)	335	134	958
MAPP - Manufacturers Association for Plastics Processors (9)	363	23	28
POFTO - Plastic Optical Fiber Trade Organization (42)	426	12	454
ACMA - American Composites Manufacturers Association (17)	560	268	341

PIA - Plastics Industry Association (1)**	706	177	896
APT_PMMI - The Association for Packaging and Processing Technologies (37)	813	56	436
IFAI - Industrial Fabrics Association International (22)	1075	55	1,024

** In some cases there are more sample members of an industry association than the total number of members given by the association itself. Please keep in mind that firms can join industry associations at various levels of the firm or subsidiary, whereas this project counts firms at the ultimate parent level, so there may be some duplication. Because all industry association variables are dummies due to the cross-nested nature of many firms, this is not expected to change the results.*

*** Plastics Industry Association (PIA/SPI) member count is actually the count of committee members provided as a courtesy to the project. The PIA/SPI does not make its membership list available to the public.*

Table A4 Multilevel Regression with Planned Emissions as Dependent Variable, Industry Association Variables, Complete Table

	(1) Planned Emissions	(2) Planned Emissions	(3) Planned Emissions	(4) Planned Emissions	(5) Planned Emissions	(6) Planned Emissions	(7) Planned Emissions
Member		-0.236	-1.031***	0.314	0.462	1.408***	2.553***
		(0.222)	(0.358)	(0.417)	(0.488)	(0.530)	(0.522)
Sustainability Committee			1.036***			5.710***	4.505***
			(0.365)			(0.729)	(0.722)
High Sustainability Rhetoric				-0.982***		-2.742***	-2.634***
				(0.381)		(0.554)	(0.550)
Medium Sustainability Rhetoric				-0.702**		-1.532***	-1.597***
				(0.345)		(0.418)	(0.435)
Low Sustainability Rhetoric				2.034***		2.182***	1.019**
				(0.386)		(0.423)	(0.429)
Members of Large Associations					-0.140	-3.564***	-3.558***
					(0.404)	(0.748)	(0.731)
Members of Medium Associations					-0.882**	-1.087***	-1.242***
					(0.362)	(0.393)	(0.409)
Members of Small Associations					0.469	-0.344	0.527
					(0.362)	(0.430)	(0.485)
High Credit Risk Firms							0.725**
							(0.331)
Subsidiary Layers							-2.733**
							(1.075)
Firm Revenue (log)							0.058
							(0.101)
Subsidiary Layers X Firm Revenue							0.121***
							(0.046)
Facility Employees (log)							-0.545*
							(0.323)
Facility Employees X Facility Employees							0.325***
							(0.071)
Facility Employees X Facility Employees X Facility Employees							-0.031***
							(0.005)

	(1) Planned Emissions	(2) Planned Emissions	(3) Planned Emissions	(4) Planned Emissions	(5) Planned Emissions	(6) Planned Emissions	(7) Planned Emissions
Public							-1.688***
							(0.550)
Small Business							-1.196***
							(0.427)
NAICS Codes Comparison Group: 325211 Plastics Material & Resin Manufacturing							
325212 Synthetic Rubber Manufacturing							1.471***
							(0.563)
325220 Artificial and Synthetic Fibers and Filaments Manufacturing							-0.265
							(0.519)
325510 Paint and Coating Manufacturing							-2.588***
							(0.261)
325991 Custom Compounding of Purchased Resins							-6.850***
							(0.392)
326111 Plastic Bag and Pouch Manufacturing							4.856
							(7.873)
326113 Unlaminated Plastics Film and Sheet (ex. Pkg) Manufacturing							-1.404***
							(0.426)
326121 Unlaminated Plastics Profile Shape Manufacturing							1.327
							(1.336)
326122 Plastics Pipe and Pipe Fitting Manufacturing							-7.596***
							(0.805)
326130 Laminated Plastics Plate, Sheet (ex. Pkg) & Shape Manufacturing							-1.629**
							(0.651)
326140 Polystyrene Foam Product Manufacturing							-10.449***
							(1.210)
326150 Urethane and Other Foam Product Manufacturing							-7.280***
							(0.528)
326160 Plastics Bottle Manufacturing							-11.371***
							(2.171)
326191 Plastics Plumbing Fixture Manufacturing							2.166**
							(0.933)
326199 All Other Plastics Product Manufacturing							-2.064***
							(0.376)
Constant	3.234***	3.308***	3.355***	3.167***	3.193***	3.102***	5.466***
	(0.262)	(0.272)	(0.272)	(0.277)	(0.275)	(0.275)	(2.078)

	(1) Planned Emissions	(2) Planned Emissions	(3) Planned Emissions	(4) Planned Emissions	(5) Planned Emissions	(6) Planned Emissions	(7) Planned Emissions
Level 2 SD "Between"	7.974***	7.993***	7.962***	7.999***	7.961***	7.879***	7.492***
	(0.197)	(0.198)	(0.198)	(0.199)	(0.198)	(0.196)	(0.188)
Level 1 SD "Within"	3.505***	3.503***	3.503***	3.491***	3.503***	3.478***	3.229***
	(0.035)	(0.035)	(0.035)	(0.035)	(0.035)	(0.035)	(0.032)
Obs.	6,044	6,044	6,044	6,044	6,044	6,044	6,044
AIC	35,036	35,036	35,030	35,008	35,036	34,950	34,143
BIC	35,056	35,063	35,064	35,055	35,083	35,024	34,371
R^2 Level 1		-0.004	0.003	-0.004	0.003	0.023	0.123
R^2 Level 2		-0.004	0.003	-0.005	0.003	0.023	0.121

Standard errors are in parentheses; *** $p<0.01$, ** $p<0.05$, * $p<0.1$; for complete table, please see Appendix. R^2 is based on Snijders & Bosker (2012). For defense of negative R^2 see Snijders & Bosker (2012).

Table A5, Multilevel Regression with Fugitive Emissions as Dependent Variable, Industry Association Variables, Complete Models

	(1) Fugitive Emissions	(2) Fugitive Emissions	(3) Fugitive Emissions	(4) Fugitive Emissions	(5) Fugitive Emissions	(6) Fugitive Emissions	(7) Fugitive Emissions
Member		-0.332	-1.962***	-1.860***	-1.658***	-1.409**	-0.755
		(0.252)	(0.405)	(0.473)	(0.553)	(0.604)	(0.599)
Sustainability Committee			2.129***			0.952	-0.011
			(0.415)			(0.818)	(0.815)
High Sustainability Rhetoric				1.784***		0.838	0.802
				(0.431)		(0.624)	(0.626)
Medium Sustainability Rhetoric				0.392		-0.474	-0.002
				(0.393)		(0.477)	(0.501)
Low Sustainability Rhetoric				0.223		0.223	-0.314
				(0.438)		(0.482)	(0.492)
Members of Large Associations					2.619***	1.334	1.387*
					(0.461)	(0.846)	(0.834)
Members of Medium Associations					-1.163***	-1.673***	-1.501***
					(0.409)	(0.450)	(0.470)
Members of Small Associations					-0.522	-0.392	-0.838
					(0.413)	(0.494)	(0.556)
High Credit Risk Firms							0.190
							(0.383)
Subsidiary Layers							-4.742***
							(1.209)
Firm Revenue (log)							-0.230**
							(0.113)
Subsidiary Layers X Firm Revenue							0.212***
							(0.052)
Facility Employees (log)							-1.354***
							(0.378)
Facility Employees X Facility Employees							0.388***
							(0.083)
Facility Employees X Facility Employees X Facility Employees							-0.028***
							(0.005)
Public							-0.302
							(0.612)
Small Business							-1.023**
							(0.490)

	(1) Fugitive Emissions	(2) Fugitive Emissions	(3) Fugitive Emissions	(4) Fugitive Emissions	(5) Fugitive Emissions	(6) Fugitive Emissions	(7) Fugitive Emissions
NAICS Codes Comparison Group: 325211 Plastics Material & Resin Manufacturing							
325212 Synthetic Rubber Manufacturing							-1.869***
							(0.657)
325220 Artificial and Synthetic Fibers and Filaments Manufacturing							1.222**
							(0.611)
325510 Paint and Coating Manufacturing							-1.442***
							(0.304)
325991 Custom Compounding of Purchased Resins							-8.946***
							(0.454)
326111 Plastic Bag and Pouch Manufacturing							-16.235**
							(8.216)
326113 Unlaminated Plastics Film and Sheet (ex. Pkg) Manufacturing							-2.219***
							(0.498)
326121 Unlaminated Plastics Profile Shape Manufacturing							-5.970***
							(1.479)
326122 Plastics Pipe and Pipe Fitting Manufacturing							-12.878***
							(0.928)
326130 Laminated Plastics Plate, Sheet (ex. Pkg) & Shape Manufacturing							-4.563***
							(0.747)
326140 Polystyrene Foam Product Manufacturing							-12.759***
							(1.401)
326150 Urethane and Other Foam Product Manufacturing							-5.580***
							(0.599)
326160 Plastics Bottle Manufacturing							-2.645
							(2.532)
326191 Plastics Plumbing Fixture Manufacturing							-1.103
							(1.008)
326199 All Other Plastics Product Manufacturing							-4.089***
							(0.428)
Constant	0.342	0.447	0.540*	0.627**	0.365	0.462	10.857***
	(0.266)	(0.279)	(0.280)	(0.284)	(0.285)	(0.288)	(2.331)
Level 2 SD "Between"	7.968***	7.985***	7.998***	7.999***	8.060***	8.063***	7.705***
	(0.203)	(0.204)	(0.204)	(0.205)	(0.205)	(0.206)	(0.201)
Level 1 SD "Within"	4.084***	4.082***	4.070***	4.074***	4.058***	4.055***	3.823***
	(0.041)	(0.041)	(0.041)	(0.0041)	(0.041)	(0.041)	(0.038)

	(1) Fugitive Emissions	(2) Fugitive Emissions	(3) Fugitive Emissions	(4) Fugitive Emissions	(5) Fugitive Emissions	(6) Fugitive Emissions	(7) Fugitive Emissions
Obs.	6,044	6,044	6,044	6,044	6,044	6,044	6,044
AIC	36,604	36,604	36,580	36,593	36,567	36,567	35,925
BIC	36,624	36,631	36,613	36,640	36,614	36,641	36,153
R^2 Level 1		-0.003	-0.005	-0.005	-0.016	-0.016	0.077
R^2 Level 2		-0.004	-0.006	-0.006	-0.019	-0.019	0.073

Standard errors are in parentheses; *** $p<0.01$, ** $p<0.05$, * $p<0.1$; for complete table, please see Appendix. R^2 is based on Snijders & Bosker (2012). For defense of negative R^2 see Snijders & Bosker (2012).