VOLUNTARY REGULATION OF THE ENVIRONMENT:
UNDERSTANDING INSTITUTIONAL FACTORS THAT SHAPE VOLUNTARY ENVIRONMENTAL PROGRAMS

by

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Final approval and acceptance of this dissertation is contingent upon the candidate's submission of the final copies of the dissertation to the Graduate College.

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Abstract

This dissertation focuses on the role of institutions in shaping the establishment, dissemination, and efficacy of voluntary environmental governance regimes. In particular, the institutional lens was introduced to understand the motivations and the mechanisms that govern the behavior of individuals in the context of voluntary environmental programs (VEPs). By drawing upon research relating to policy design, regulatory innovation, and the policy feedback theory, I explore and analyze how regulatory, individual, and institutional based factors complementarily influence the adoption and efficacy of the VEPs. Given the growing need for reducing environmental impact, such insights can help policymakers better understand the appropriateness and efficacy of different policy instruments in managing the environment.

To fulfill my research agenda, I conduct three empirical tests to not only show whether the voluntary instruments are effective in addressing environmental problems but also how and under what conditions such instruments can help and produce a broader effect on society as a whole. First, I provide a meta-analytical test of the effects of VEPs on improving environmental performance, finding that the institutional design elements of the programs can explain why VEP studies over the past twenty years have drawn different conclusions about VEP efficacy. I also examine one specific voluntary program: the green building standard, LEED. I look at different factors leading to LEED adoptions. A cross-country study of LEED adoptions explains why VEPs develop in some countries but not the others. Different from existing literature that focuses more on individual level corporate practices, I explore whether country-level factors such as income level and regulatory stringency can explain the dissemination dynamics of VEPs. To extend on this adoption dynamics, I also examine "public adopters". I investigate the scenario when public regulation integrates a private regime, such as LEED, in laws and even make the voluntary commitments mandatory. I analyze how interest groups respond to such a policy change and how this will impact the future trajectories of sustainability transitions. The overall findings of this dissertation indicate a prominent role of institutional design in developing VEPs, provide implications for policy practitioners that VEPs might be helpful in addressing green investment deficits, and add to the growing understanding of local governments as innovators in aspects of environmental governance.

Chapter 1 Introduction

Over the past decade, concerns over the decreasing amount and quality of available natural resources have risen dramatically. Questions surround policymaking of better environmental governance. How should the environmental policy change in order to slow down the unfavorable degradation of the environment? What approaches should be at the heart of environmental policies, and how much impact should governmental regulations have? Scholars and policymakers are increasingly recognizing that a broad array of regulatory instruments is required and desired to manage environmental quality. Traditionally, policies are built on the regulation system with centralized government agencies and top-down creation and implementation of rules imposed on businesses and organizations. However, in recent years, there has been considerable dissatisfaction towards such a centralized government regime due to administrative burdens, technological rigidity, and imperfect compliance (Brewer and Stern 2005; May 2005). Criticism of these traditional regulatory tools has drawn attention to alternative institutional forms including voluntary instruments.

Voluntary environmental programs (VEPs), which are advocated to be more flexible and economically efficient than the government-led command and control regulation, have emerged as an important instrument in environmental governance. Conditional on joining, VEPs induce individual actors to voluntarily produce positive environmental externalities, such as public goods, beyond their legal requirements. Darnall and Carmin (2005) develop one of the earliest theoretical approaches to explain the mechanism of VEPs. They argue that VEP participation provides valuable information about members' commitment to environmental stewardship which is otherwise unobservable to most external stakeholders. Prakash and Potoski (2007a) establish the VEP mechanism based on the economic theory of clubs. They suggest that VEPs offer non-rivalrous but excludable benefits in the form of positive reputations associated with the adoption of and adherence to sustainability requirements. In all, as scholarship has identified, there are two major mechanisms to make VEPs work. The first one is performance or intrinsic benefits, indicating that when firms join a VEP, they get to know some advanced technologies and skills to lower operating costs, improve productivity gains, and increase their efficiency. Second, there is the signaling effect. VEP participants can signal their environmental stewardship to differentiate themselves from peers. sell their product with a probably higher price, they can gain some consumer loyalty, and able to get more investment (Berliner and Prakash 2013; Darnall and Carmin 2005; Darnall and Sides 2008; Prakash and Potoski 2012).

However, some puzzles still remain. Some of them have not been brought up with current scholarship, and some of them may have been discussed but scholars have not reached a consensus yet. First, whether and how VEPs can address the free-rider problem and whether this voluntary mechanism is effective or just "greenwashing". As Prakash and Potoski (2012) have theorized, VEPs can offer their members excludable branding benefits, so they could potentially correct public goods problems to incentivize the environmental behaviors of VEP participants. However, within the program, firms may still behave differently, and the free-rider problem can still exist among the program participants. For example, firm A might choose to cost less but still enjoy the branding benefits other firms have created. Institutional design theories argue that the

design elements can shape actor incentives. However, which kind of design is more effective is still unclear.

Second, though scholarship has argued two types of benefits as mentioned, it is not enough to explain under what conditions VEPs are more likely to have greater levels of participation. If we consider firms in different jurisdictions, then why do more firms choose to adopt VEPs in some jurisdictions, but not the others? Existing literature has reinforced cross-jurisdictional influence. For example, firms in jurisdiction A may emulate other firms in neighboring jurisdictions or some other jurisdictions that have close relationship or share some common features with the firm's jurisdiction A, like common language or close trade relationships. There is extensive literature investigating these cross-jurisdiction emulations. However, there are also within-jurisdiction factors, but they are less explored. There is significant heterogeneity among jurisdictions in regard to economic, demographic, biophysical, and institutional arrangements. Importantly, we have different environmental policies produced and enforced by the government. So here, although we consider private voluntary regulation as a supplement to public regulation, it is not clear to the scholarship that whether good or bad public regulation will help promote the development of voluntary programs. And subsequently, help us understand the conditions under which VEPs can have better development.

Following the second puzzle that discusses the impact of public regulation on VEPs, the literature also lacks the discussion of the impact of VEPs on public regulation. As VEPs develop, the society is gradually seeing a higher bar of environmental sustainability. So, will this impact the settings of public regulation? Will public regulation raise their compliance bar as well due to the development of VEPs, and will they even just use the private programs to help their governance? At the same time, political science literature has argued that policies are more like a collaborative creation of multiple agents, including not only the government but also the firm and other stakeholders. So, in this process, would there be any supportive or opposing groups coming in? And how the policy changes as a consequence of business interaction with governments and other bodies. In all, will private regimes such as the VEPs, be able to produce broader effects to the whole society?

Above all, despite VEPs' promise and proliferation, concerns over the voluntary nature of the VEP mechanisms drive questions surrounding participation motivation and program efficacy. VEPs are designed the institutions to create incentives for actors to voluntarily incur the costs to protect the environment (Prakash and Potoski 2007a). Whether actors choose to participate and comply with the VEPs is dependent upon their assessment of the costs and benefits. The calculations presumably rest not only on their own business model and organizational characteristics but also on what kinds of benefits and costs the voluntary program can actually offer (Coglianese and Nash 2009). The rewards offered to participants, and the behaviors expected of them to join and remain in the program, reflect how the VEP institutions structure the behavior opportunities and constraints available. Understanding the VEP mechanism necessitates understanding how institutions, in general, shape actor incentives and behaviors. The relationship between actors and institutions can be informed primarily by three factors: (1) the design of institutions, which encourages or compels participants to adhere to sustainability guidelines; (2) the mechanisms established to enforce these institutions, which can be context-dependent and can be conducted via both public and private based systems; and (3) the internally- and externally-based motivations that influence how individuals interpret and choose

to respond to institutional directives (Siddiki 2011). This dissertation analyzes public and private forms of environmental governance as a problem of institutional arrangements. In this way, it will advance the understanding of how institutions solve complex social dilemmas and sustain environmental development.

To lay the intellectual foundation for the dissertation, in the second chapter, I examine how institutional design elements shape VEP efficacy. In particular, by prescribing a set of opportunities and constraints available to a variety of actors, policy instruments, like VEPs, are the institutional arrangements that policy designers use as vehicles to achieve desired outcomes. Packaged with different institutional design elements, VEPs are not expected to be equally effective. The institutional design explicates why some VEPs achieve large positive environmental outcomes while others fail. In this paper, entitled "Institutional Design and The Effects of Voluntary Environmental Programs (VEPs): A Meta-analysis", I begin by focusing on the institutional design characteristics of different VEPs and discuss how institutional design decisions mediate unwanted participant behavior such as freeriding and shirking and the extent to which policy design can help achieve program goals. Through a comprehensive quantitative review of published VEP efficacy literature, I examine the aggregate relationship between VEP participation and efficacy and how the outcomes differ between different dimensions of the institutional characteristics.

Analyzing environmental governance as a problem of institutional design reframes the governance question to one that considers a full range of design options, and also inspires the thread of thoughts seeking to match institutional forms to specific governance needs. In the third chapter, entitled "Private Governance Regimes and Public Regulatory Settings: The Global Adoption of LEED Certification," I turn to a discussion of how variation in the institutional environment impacts participatory choices made by individual actors. Using global country by year panel data, I examine the cross-country adoption of a private international building standard, the Leadership in Energy and Environmental Design (LEED) certification, which was established by a non-governmental organization, the US Green Building Council (USGBC). In this chapter, I test how domestic public institutions shape actor incentives to adopt such a private voluntary institution for environmental governance, and how they moderate the effects of economic development on the global dissemination of the private governance regimes. Moreover, this paper extends existing theory by paying attention to the level of adoptions, that is, how signaling effects and performance considerations are shaped by domestic institutions in the choices of LEED certification level. The findings of this chapter highlight VEPs' signaling effects and performance considerations in their calculated decisions.

Lastly, I expand the discussion to investigate how private voluntary institutions can shape public regulatory institutions and examine the interrelated roles of government and private sectors in a complex governance system. To this end, the fourth chapter, entitled "Policy Feedback and State Adoption of LEED", examines public adopters. It draws attention to the policy legacies of private programs and the feedback consequences for further policy change. Using panel data across the United States at the state by year level, I model institutional change at the state government level to test whether policy adoption is associated with subsequent change of political activities and whether this association can be different under different contexts. This study could be an important attempt for advancing quantitative analysis in the area of policy feedback theory because there is few if any, existing empirical evidence of this type of

policy effects. Besides, since the environmental policy literature often neglected the role of policy feedback in environmental policy processes, this paper is also expected to provide implications for feedback studies in the area of environmental policy studies and adds to the growing understanding of local governments as innovators in aspects of environmental governance that are beyond the scope of the tradition government-led command-and-control instruments.

This dissertation introduces the institutional lens to understand the motivations and the mechanisms that govern the behavior of individuals in the context of voluntary environmental programs. By complementarily drawing upon research relating to policy design, regulatory innovation, and the feedback theory, the research shows how regulatory, individual, and institutional based factors complementarily influence the participation and efficacy of voluntary programs. Given the growing need for environmental protection and the shortage of available resources to meet the need, such insights can help policymakers better understand the appropriateness and efficacy of different policy instruments in managing the environment.

Chapter 2 Institutional Design and the Effects of Voluntary Environmental Programs: A Meta-analysis

2.1 Introduction

Over the past decades, voluntary environmental programs (VEPs) have become important policy instruments for environmental governance. Scholars have proposed the rationale behind voluntary programs that when their participants pursue improved environmental performance, the programs, in turn, would offer the participants branding or reputational benefits for doing so (Darnall and Carmin 2005; Prakash and Potoski 2007a). While some voluntary programs are demonstrated to have taken progressive steps to produce a high level of environmental outcomes, others are reported as failing to show any achievement of environmental goals (Prakash and Potoski 2007a, 2012). Take the case of two of the most examined voluntary programs, ISO14001 and 33/50. The former is an environmental standard established by a nongovernmental organization, the International Organization for Standardization (ISO), which requires its participants to adopt the best available environmental management practices (Cao and Prakash 2011; Prakash and Potoski 2014). In contrast, 33/50 was launched by the U.S. Environmental Protection Agency (EPA) in 1991 to encourage voluntary reductions of the emission of 17 high-priority toxic chemicals (Khanna and Damon 1999). Most of the ISO14001 studies found that program participation is associated with improvement in environmental practices (Arimura et al. 2016; Arimura, Darnall, and Katayama 2011; Arimura, Hibiki, and Katayama 2008; Darnall and Kim 2012; McGuire 2014; Ozusaglam, Robin, and Wong 2018; Potoski and Prakash 2005a).[1] However, scholars mostly do not report pollution reductions in the context of 33/50.[2] The variation is seen in other VEPs as well. These examples include the successful cases of Green Lights (Moon, Bae, and Jeong 2014) and Forest Management Certification (Miteva, Loucks, and Pattanayak 2015). Unsuccessful ones include programs such as Responsible Care (A. A. King and Lenox 2000) and Climate Challenge (Welch, Mazur, and Bretschneider 2000).

What explains the efficacy variations of different voluntary programs? Institutional theory has suggested that the design characteristics of VEPs can explain their functioning variations. For example, the absence of third-party supervision is argued to welcome "free-ridership" of some participants (Darnall and Sides 2008; Potoski and Prakash 2005a; Rivera and deLeon 2004). In fact, myriad institutional forms exist in VEPs providing different incentives that impact program participants' strategic behaviors and program efficacy. In this paper, I use the lens of institutional design to explain why some VEPs succeed and others fail. Many existing studies have investigated the efficacy of different VEPs, but most focused on one single program, one single pollutant media, or one single country. Since VEPs have inconsistent purposes, scopes, and targeted clients, a systematic quantitative review of cross-program evaluation is necessary. Meta-analysis with nuanced estimation procedures could be an effective option.

[1] Exceptions include some ISO14001 studies in Mexico (Blackman 2012; Henriques, Husted, and Montiel 2013)
[2] Exceptions include relatively earlier studies conducted by Khanna and Damon (1999), and Innes and Sam (2008).

Darnall and Sides (2008) employed a meta-sample comprising 9 studies and 11 estimates to test the effectiveness of VEPs requiring self-monitoring as opposed to those requiring third-party certification. As the only existing meta-analysis of VEP efficacy, their study offers valuable contributions to this topic by examining the overall efficacy of VEPs and providing evidence for the benefits of external monitoring.[3] By contrast, in this study, I center more on the institutional design of VEPs and intend to explore the best design solutions for environmental governance. Moreover, with a broader time span and more advanced meta-analytic techniques, this study exhibits important empirical advantages. In particular, I first performed an exhaustive review of the empirical VEP literature from 1999 to 2019 that examined how VEPs matter for firm-level environmental improvement. Then I employed meta-regression procedures to estimate the correlation between VEP outcomes and different dimensions of VEP design characteristics such as monitoring, public disclosure, educative assistance, and sponsorship.

This study makes four main contributions to the literature. First, it introduces a comprehensive view of institutional design to explain the different outcomes of VEPs. This analysis contributes to the understanding of how program design mediates unwanted participant behaviors such as shirking and the extent to which design can help achieve environmental stewardship goals. Second, it updates the only available meta-analysis of VEP efficacy with more advanced meta-regression analysis and several times more of the number of primary studies and estimated effect sizes. This empirical advantage is expected to engender discussion and development of the use of meta-analysis in estimating the effects of policy actions. Third, with a rich collection of supplementary information on the VEP studies (such as estimation methods and time span) and the programs themselves (such as program designs), this study is able to explore different sources of heterogeneity across program designs and performances. Last, this study demonstrates the utility of VEPs in promoting environmental performance, which is the opposite of the negative VEP effects found in Darnall and Sides (2008). The new evidence presents in this chapter contributes to the discussion of voluntary environmental measures by producing implications for how scholars assess the environmental effects of voluntary programs and for how organizers design policies to promote environmental protection endeavors.

2.2 VEPs and Environmental Performance

VEPs emerged in the 1980s to foster environmental values and action. They are construed as rule systems, codes, and agreements that business organizations voluntarily commit to reduce their environmental impacts beyond legal requirements (Darnall and Sides 2008; Potoski and Prakash 2013). Though VEPs require participant organizations to establish specific environmental targets and commitments, the term of VEPs implies an important attribute that there are no formal laws and legislations that mandate firms to join such programs. In the legal sense, organizations are free to enter or exit a VEP and there should not be any public regulatory liabilities or penalties for nonparticipation. This makes the instrument flexible and less rigid in use. As they achieve widespread dissemination across sectors and countries to address environmental concerns, VEPs

[3] Flankova et al. (2018) could be another existing meta-analysis. However, only a 6-page abridged version of this study is available. Subsequent formal journal publication is expected.

take many forms. Scholars categorize VEPs in different ways to reflect their varied forms. For example, Borck and Coglianese (2009) suggested that VEPs include industry unilateral environmental commitments, bilateral agreements between industry and government, and multi-stakeholder programs involving industry, government, consumer, investors and more. Some scholars, such as Potoski and Prakash (2013) and Carmin et al. (2003), examined VEPs sponsored by three types of actors: governments, industry associations, and nongovernmental organizations (NGOs). Moreover, empirically, Darnall and Sides (2008) and Vidovic et al. (2019) tested the environmental effects of external audited VEPs in compared with self-monitored ones.

As a policy instrument designed to offer nonmandatory approach to mitigate environmental problems, it is a question of how VEPs can effectively address collective action challenges and reduce environmental impacts. Based on the economic theory of clubs, Prakash and Potoski (2006, 2007a) developed an institutionalist approach to study VEPs. This approach addresses how VEPs mitigate the information problems between firms and their stakeholders. They suggested that VEPs offer non-rivalrous but excludable benefits in the form of positive reputations associated with the adoption of and adherence to sustainability requirements. The reputation signal allows stakeholders to differentiate environmentally responsible firms based on their membership of a recognized VEP. In this way, such VEPs are able to offer their participants reputation benefits to offset the costs of environmental actions that the membership requires. Further, Potoski and Prakash (2013) established that VEP participants need to secure these benefits from the program's overall reputation which depends strongly on its ability to address challenges associated with collective actions. For example, shirking may occur because firms have incentives to join a VEP but not adhere to its obligations. Scholars have mentioned that some institutional features – such as monitoring and sanctioning mechanisms, information availability and quality, and types of implementing agencies – might play a role in addressing the shirking problems. For example, ISO14001, one of the most widely recognized VEPs, requires participants to implement environmental management systems and to be audited by an independent third party. However, due to missing evidence or inconclusive findings, scholars are uncertain if VEPs with the above institutional features can significantly differentiate from each other in changing environmental behavior.

2.3 Institutional Design and Hypotheses Construction

Given its role in shaping actor incentives, institutional design is a critical factor in understanding policy impact. In this review, I examine four design elements that are salient and most studied in VEP literature and delve into their impacts on the outcome of VEPs: monitoring regimes, public disclosure, educative assistance, and sponsorship.

2.3.1 External Auditing vs. Internal Monitoring

Monitoring can increase the confidence of individual participants that others are following the collective rules. Monitoring is a continuous process of obtaining information to determine if program participants are complying with program rules. It collects information on individual compliance efforts and makes those who do not comply visible to the others. By informing the

behavior of those who do and do not comply with rules, monitoring shapes individual perception of collective compliance, and makes it costly for program members to freeride or shirk their responsibilities (Cox, Arnold, and Villamayor Tomás 2010). As a result, monitoring facilitates the efficacy of commitment fulfilment. Through studying the strength of the local forest institutions in Kumanon Himalaya, India, Agrawal and Yadama (1997, 455) found that "the number of months a local forest guard was hired has a very strong and statistically highly significant direct effect on forest condition." Their empirical study showed that monitoring facilitates credible commitment by program participants and the intensity of the incentives to comply with program rules strongly corresponds to the intensity of monitoring.

The intensity of monitoring differs between external and internal monitoring regimes. Principal-agent theory suggests that in work relations, individuals would take every opportunity to lighten their load of work responsibilities and difficulties on the condition that their shirking would not suffer from a severe punishment that the net utility turns negative (Frey 1993). The calculated costs of such opportunistic behaviors are different between external and internal monitoring regimes. External auditing with standardized procedures brings outside pressure on program participants. In this way, the probability of getting caught shirking or freeriding is increased together with increased costs of reputational damage. Therefore, when external auditing is present, the costs of incompliance are higher, and correspondingly, VEP participants are more likely to fulfill their environmental commitments. On the contrary, internal monitoring only requires participants to self-report the fulfillment of their commitment. This self-reporting mechanism helps ease participants' administrative burden and encourages them to identify unrecognized problems themselves without threats of reputation damage. Since it is difficult for other members or stakeholders to detect misreporting or shirking, participants of self-reporting VEPs have less incentives to fulfill their environmental commitment. For instance, firms can avoid potential administrative punishment or reputational loss by "exploiting loopholes in the self-reporting monitoring mechanism such as diluting samples, discharging pollutants through hidden pipes, and arbitrarily changing the parameters of monitoring equipment" (Peng et al. 2019, 1348). Accordingly, the effects of different levels of monitoring intensity are shown in the meta-analysis of Darnall and Sides (2008) that VEPs requiring certification and independent third-party monitoring improve participants' environmental performance to a greater degree than those VEPs requiring self-monitoring alone. Thus, it suffices to expect that

> **Hypothesis 1**: VEPs with an external auditing regime have stronger effects than those with a self-monitoring regime in producing positive environmental outcomes.

2.3.2 Public Disclosure

There is information asymmetry between program participants and their stakeholders. Consider a situation where half the VEP participants follow the sustainability requirements and the other half do the opposite. Stakeholders usually do not have sufficient resources and information to distinguish these "good" and "bad" participants. As a result, the "bad" ones may claim their actions are as sustainable as the "good" ones. In turn, stakeholders would appraise both good and bad firms at an average level (Healy and Palepu 2001). There can be two consequences: first, program participants are incentivized to be the "bad" firms rather than the "good" firms because the "bad" ones are being overvalued and the "good" ones are undervalued by the stakeholders;

and second, the average benefits each participant can claim would decrease because of the presumable decline of trust in the program's environmental stewardship. In all, the information problem entails collective problems and potentially lead to a breakdown in the functioning of VEPs.

To address the information asymmetry between participants and their stakeholders, public disclosure scheme is often adopted in VEPs. Though monitoring procedures provide VEPs with the access of information on individual compliance, the information is transparent only in a limited manner. The public disclosure scheme, in contrast, raises the level of transparency to allow a broader range of stakeholders to track the environmental records of program participants. Like monitoring regimes, information disclosure alters the incentive structure of the program participants. Analysts describe a "shock and shame" dynamic: when risk information is released to external audience (such as citizens, the media, government agencies, and the markets) and generate feelings of compassion and outrage among them, firms are shamed and likely to initiate changes from within (Beierle 2004; Lahti 2018). Greater awareness of risks may lead stakeholders to pressure program members for environmental stewardship and raise the opportunity costs of incompliance and misreporting. As a result, program members are less likely to shirk their responsibility within the program, thus

> **Hypothesis 2:** VEPs with information disclosure rules have higher environmental efficacy relative to VEPs without any disclosure rules.

2.3.3 Interaction Between Monitoring Mechanisms and Disclosure Rules

As stated above, when VEPs add rules of external auditing or public disclosure, their participants are imposed significant external pressure and are more likely to take on their environmental obligations. External auditing has a stronger effect on program efficacy than self-reporting, regardless of the existence of information disclosure. Similarly, public disclosure has a stronger effect on voluntary program efficacy in environmental improvement than otherwise, regardless of the type of monitoring. However, it is also worthwhile to know whether the mix of these two designs has different impacts on program efficacy. In Margret Levi's *Of Rule and Revenue* (1988), she used a term "quasi-voluntary compliance" to describe a situation in which individuals are willing to comply with rules when they perceive that others also comply. That is to say, commitment fulfilment is not just a result of enforcement procedures that affect individual's calculated probability of getting caught and being punished, but also related to the manner in which they care about whether others are paying their fair share and whether the whole system is effective. When a VEP set up rules to monitor its participants' behaviors and disclose their environmental information, such external pressure reinforces the confidence of individual participants that others are following the same program rules and making the same efforts to achieve their collective objectives. I hypothesize that VEPs with both external auditing and information disclosure are the strongest in producing environmental efficacy, whereas VEPs with either information disclosure or external auditing have weaker effects than the programs having them both. Therefore,

> **Hypothesis 3:** VEPs with both an external auditing regime and public disclosure rules have higher efficacy relative to VEPs with either an external auditing regime or

information disclosure rules.

2.3.4 Educative Assistance

Some VEPs deliver technical assistance or educative service to help their participants get familiar with either public regulations or cutting-edge industry technologies (Darnall and Carmin 2005). In essence, technical assistance develops innovative and cost-effective ways to offer program participants targeted support to address problems, build capacity, and achieve systematic change. For example, EPA initiated the Strategic Goals Program (SGP) in late 1997 and negotiated with the metal finishing trade associations and other stakeholders to set pollution prevention goals. To help program participants meet the goals, SGP established the National Metal Finishing Resource Center (NMFRC) where participants could seek technical assistance in pollution prevention techniques. SGP also offers free workshops, on-site technical assistance, and funding opportunities for adopting and developing environmental technologies. Such type of educative assistance, as a critical channel for firms to acquire credible information and technical support, is expected to be associated with positive environmental outcomes.

However, critics of educative assistance doubt that this policy tool is indeed a cover for "greenwashing". In contrast with the deterrent enforcement tools mentioned above, VEPs with educative assistance itself only encourage rather than mandate substantial changes in their participants' environmental practices. Therefore, the assistance tool, with a superficial display of environmental stewardship, potentially works as a strategy for opportunists to acquire the same reputational benefits with constrained costs. Take the case of SGP. Participants received recognition from EPA and could qualify for regulatory relief, but Brouhle et al. (2009) found that SGP yielded little, if any, additional reductions in emissions. This indicates that when there are not any substantive requirements (e.g., external monitoring or disclosure rules) included in a voluntary program, the environmental signals conveyed through the VEPs are more likely to be insignificant and unreliable (Darnall and Carmin 2005). As a result, the expected benefits from participating in such a program shrink, and the participants are not motivated to fulfill their environmental obligations. Educative assistance is likely a weak program design with limited effects of motivating program participants to improve environmental practices. Therefore,

> **Hypothesis 4**: the provision of educative assistance is not necessarily associated with environmental efficacy of VEPs.

2.3.5 Sponsorship

When designing institutions, in addition to the question of what decisions are made, who is entitled to manage also matters. In practice, VEPs can be privately owned by firms or their industry association, or publicly controlled by the government. The way these sponsors involve stakeholders in the programs and the approach they use to encourage progressive environmental actions by their participants can be dramatically different. Scholars usually divide the VEP sponsors into three categories: industry and trade associations, government agencies, and third-party organizations (Carmin, Darnall, and Mil-Homens 2003; Darnall and Carmin 2005; Potoski

and Prakash 2013; van't Veld and Kotchen 2011). Existing research typically focuses on the requirements these different programs impose on their participants, yet Darnall and Carmin (2005) demonstrated no significant differences of design components among VEPs with difference sponsors. Based on this finding, instead of focusing on variations in program designs due to sponsorship, I examine how program sponsorship influences firms' incentives to fulfil their environmental commitments beyond the design indicators of the programs.

To start with, some industry and trade associations establish VEPs to provide collective goods, such as environmental reputation, to their members. Even though these programs have explicit objectives in addressing environmental challenges, they inevitably focus more on the profits of their members, and the foremost objective should always be the maximization of average program profits (van't Veld and Kotchen 2011). How about when pollution prevention is incompatible with their profit-maximizing goal? While the establishment of a industry-sponsored VEP can protect and even enhance the environmental reputation of the industry, pollution problems of one single firm may potentially cause negative reputational externalities to other firms in the industry regardless of its membership in the VEP (Potoski and Prakash 2013). Due to this, many industry associations try to expand the membership base of their VEPs and sometimes even require universal membership across the industry. Under this situation, many firms without strong incentives for environmental improvement are forced to join the VEPs. Industry sponsors may set up such stringent rules as external auditing or public disclosure to meet the common goal of pollution reductions shared with environmentalists and regulatory agencies, yet they are also responsible to secure program benefits and constrain their members' expenditure within their budget. This partly explains why there are criticisms that their programs are more like "greenwashing", that is, "not impose real beyond-compliance obligations on their participants while mouthing pious environmental platitudes" (Prakash and Potoski 2014, 370). In industry- sponsored VEPs, participants are more likely to follow the crowd with modest obligations, and the aggregate level of environmental improvement is likely to be modest.

On the contrary, many environmental groups and other independent third parties opt to sponsor VEPs, often because they are frustrated with formal forms of government regulations (Potoski and Prakash 2013). The third-party sponsors usually establish VEPs with explicit objectives of maximizing environmental public goods and sorting the green firms from the less green ones (Prakash and Potoski 2012; van't Veld and Kotchen 2011). They often leverage the unique benefits offered by small and new market preferences for sustainable acts arising from supply chain and consumer demands, and therefore create programs in industries such as forestry, agriculture, and tourism (Steelman and Rivera 2006). Since the third-party sponsors, especially for these topic areas, share the environmental and health concerns with the broader community, no matter what program rules they set up, they must ensure the ultimate goal of environmental improvement. As a result, these VEPs tend to prioritize performance over process, and the tolerance of incompliance is assumed to be lower. It is thus expected that the enforcement of program requirements in third-party sponsored VEPs is stricter. Since actors can venue-shop across VEPs, actors with strong community or societal pressures to improve their environmental performance likely crave positive publicity from a third-party certified environmental stewardship, they are more likely to join a third-party sponsored VEP (Darnall, Potoski, and Prakash 2010). Therefore, participants of third-party sponsored VEPs tend to be those who are more determined to improve their environmental practice and consequently show

a higher level of environmental stewardship.

For governments, sponsoring a VEP is a cost-effective approach to minimize both the administrative burdens and the adversarial relations with businesses and nonprofit organizations (Darnall, Potoski, and Prakash 2010; Steelman and Rivera 2006). Accordingly, when a government agency establishes a VEP, it often attempts to retain the program's flexible and voluntary nature as much as possible. In another word, environmental improvement is not the sole goal of government-sponsored VEPs. They need to balance between the extremes of stringency and flexibility and mediate between the environmental and business demands (Steelman and Rivera 2006). For this reason, participants of government-sponsored VEPs are more likely to be interested in building relationships with regulators and are anticipated to fulfill "good enough" commitments. Therefore, compared with third-party sponsored VEPs, government-sponsored ones tend to be less ambitious in environmental improvements, and may show modest outcomes. That being said, sponsorship probably matters beyond the program design features and produces different environmental outcomes. As for the average efficacy of these types of VEPs,

> **Hypothesis 5**: conditioning on the institutional design characteristics (i.e., monitoring, disclosure, and assistance), third-party sponsored VEPs are more effective relative to government- and industry-sponsored VEPs in producing positive environmental outcomes. [4]

Although prior research has recognized the potential problems of VEPs sponsored by government agencies or industry associations, it is not clear as to whether a program collectively sponsored by these two types of organizations would be rewarding in correcting these problems. Collective sponsorship has received widespread support in VEPs. For example, the Climate Challenge Program is a joint program based on an agreement between the US Department of Energy (DOE) and the US electric utility industry to lower greenhouse gas emissions. Though capture theory argues that businesses are strongly motivated to influence regulators so that they serve their interests rather than the general public (Stigler 1971), recent evidence reveals that such capturing is not inevitable and there are indeed substantial benefits of the collective sponsorship (Lehmann 2006; Pongsiri 2002; Wong, Wei, and Tjosvold 2014). First, collaboration is an approach in which a mixture of complementary resources and knowledge is brought to bear on the problem of environmental improvement. When government agencies make an attempt to create and maintain a viable operating environment to scale up solutions, businesses bring useful information and entrepreneurial spirit to generate codes of "good practice"(Garcia Martinez et al. 2007). When businesses provide access to reliable information and advice, agencies are instrumental in coordinating around public infrastructure and resources to support constant efforts in environmental stewardship. The government-industry collaborations

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[4] Some scholars also argue that industry associations can be more effective in producing environmental outcomes because their expert knowledge and their role in shaping the governance (Ponte and Cheyns 2013). Due to limitations of available resources, NGO sponsored VEPs are argued to be weaker in environmental outcome (Prakash and Gugerty 2010). Therefore, competing arguments exist which states that industry-sponsored rather than third-party sponsored VEPs could be the most effective relative to government and third-party sponsorship VEPs in environmental outcome. Yet, the hypothesis shown in the main text is more widely accepted in literature.

show clear benefits of achieving a greener outcome. Moreover, collaborative sponsorship can be seen as an institutional means of dealing with greenwashing problem by creating mutual accountability between the two parties. Working in partnership with another sector comes with inherent risks, including to reputations. Such risks are real for both the businesses and the government. Consequently, both parties are motivated to raise compliance levels and improve the level of environmental performance.

> **Hypothesis 6:** conditioning on the institutional design characteristics (i.e., monitoring, disclosure, and assistance), cooperative-sponsored VEPs are more effective in producing positive environmental outcomes, compared with those sponsored by solely industry associations or solely government agencies.

2.4 The Data

To evaluate these hypotheses, I adopted meta-analytic techniques to investigate the aggregate relationship between VEP participation and environmental performance. This approach provides a systematic and unbiased way to synthesize the entire body of VEP literature and offer reliable statistical estimates regarding the aggregate relationship between VEPs, their institutional design features, and their environmental performance. Following the guidelines for meta-analysis in public management and policy provided by Rinquist (2013), I started with a comprehensive literature search of all published empirical articles that include quantitative assessments of VEP efficacy. I extracted all point estimates of VEP outcomes from these articles and computed the effect sizes that reflect the comparison of program participants and nonparticipants. After I recorded and coded every study to determine the type of VEP institutional characteristics (including sponsorship, monitoring schemes, information disclosure, and educative service), I generated descriptive statistics to show, in general, how environmental outcomes differ between different dimensions of the institutional characteristics. Then, I performed meta-regressions of the estimated effect sizes to investigate the aggregate relationship between VEP participation and environmental performance and examine whether and how institutional designs impact program efficacy. I explain the steps as followed.

2.4.1 Literature Search and Inclusion Criteria

To identify the studies of interest, I adopted three major criteria to which a study should conform. First, the studies into review should be the research on “any program, code, agreement, or commitment that encouraged business organizations to voluntarily reduce their environmental impacts beyond that required by the environmental regulatory system” (Darnall and Sides 2008, 101). There are four most significant features of this definition of VEPs. First, the programs should be “voluntary” which means firms are free to enter without legal mandates, and there are not any substantial financial incentives to distort the incentives. Next, the programs should be “environment targeted”. This means voluntary programs such as Occupational Safety and Health Administration (OSHA) which promotes worksite-based safety were not included. Third, the programs are “commitment-based” which means firms should dedicate themselves to some environmental stewardship goals. In this regard, solely information-based environmental programs such as Carbon Disclosure Project, 1605(b), and other market-based policy

instruments, such as emission trading, taxes, charges, and subsidies, were excluded. Lastly, the programs should be "business-based" which means the ones targeting residents or public governments were not included in the review.

Second, I limited my search to published journal articles. Though conference proceedings and book chapters are important sources of valuable works, the results of these works are more likely to duplicate the work their authors publish in peer-reviewed journals. The inclusion of multiple publications of the same study within a meta-analysis may introduce unfitting weight to the duplicated data if the duplicated publications are not well linked together (Fairfield, Harrison, and Wigmore 2017). To avoid significant bias from inadvertent inclusion of the same study more than once, I arbitrarily gave up the inclusion of books. Besides, since there is a significant concern of selection bias associated with VEP participation, the estimation of VEP effects should be able to address the error term that is correlated with the participation decision. Considering that peer-reviewed journal articles are more extensively scrutinized by the scientific community (Darnall and Sides 2008), this choice is more likely to produce reliable findings and implications.

Third, the studies into review should have a quantitative assessment of firm-level environmental impacts. That being said, my review left out studies with no numerical information or statistical tests. The outcome variable should be an "environment" figure, including pollution releases, environmental innovations, or other environment-related practices. This means outcome measures such as consumer perception and financial performance were not included. Besides, considering the validity of assessing program performance, the review only considers studies with pre-post treatment-control designs. Studies with pre-post-only design were excluded.

To locate the studies for the review, I conducted an exhaustive search via Web of Science. Since there is not a consensus on naming this voluntary policy instrument, I adopted a relatively wide word combination for the search of VEP efficacy studies. The combination of words used for this exercise was:

(voluntary environmental program* OR voluntary environmental initiative* OR voluntary policy instrument* OR environmental management system* OR environmental management standard* OR eco-label OR eco-certification*) OR ((voluntary program* OR self-regulation without sanction) AND (environment* OR green OR sustainab*)) AND ("quantitative" OR "data" OR "sample" OR "panel" OR "estimat*" OR "evaluat*" OR "investiga*" OR analyz* OR regress* OR model OR find* OR found OR result* OR empirical OR evidence OR predict* OR outcome*)[5]

This word combination permitted me to enlarge the search by including a broad range of naming conventions, including but not limited to green clubs, private or public environmental agreements, or voluntary environmental initiatives. The initial keyword search on Web of Science produced a total of 1467 articles across the years 1992-2019. 105 of them were considered to be relevant studies that evaluated salient characteristics and related aspects of VEPs. Of these, 43 articles across the years 1999-2019 quantitatively assessed the environmental

[5] The use of * as the wildcard character permits me to enlarge the search by substituting a sequence of letter. For example, searching for environment* will retrieve environment and environmental.

performance of VEPs with variant quantitative methods. These studies met my inclusion criteria and were included in the following analysis. The studies with their tested VEPs are present in Table *2.1*.[6] Across these studies, 18 VEPs with different institutional designs were examined.

2.4.2 Effect Size Extraction and Calculation

To conduct the meta-analysis, empirical results from all primary studies need to be transformed into effect sizes – the common metric and often the unit of analysis in meta-analytical studies. The effect sizes in this study represent the standardized relationship between VEP participation and program outcome and were calculated from the statistical results of all primary studies. This includes mean differences and correlation coefficients. The majority of my sampled studies produced multiple results because they employed different model specifications or sample restrictions to assess the robustness of their empirical results. The traditional advice within meta-analysis would be to use the "one best" effect size or calculate a single average effect size from each primary study. However, this strategy would discard large amounts of information, and more importantly, prevent researchers from identifying important sources of heterogeneity between studies (e.g., study contexts, research designs, or model specifications). To avoid arbitrary selection and acquire information as complete as possible, I used all effect sizes coded from primary studies as observations.

I calculated a total of 502 effect sizes based on the parameter estimates, standard deviations, and degree of freedom reported in the 43 sampled studies. As a comparison, Darnall and Sides (2008), the only other meta-analysis on VEP efficacy, included 9 empirical studies in their meta-sample. For 7 of the studies, they chose one single effect size from each of the studies; for the other 2 studies, they averaged the point estimates. They produced a subgroup analysis comparing VEPs requiring self-monitoring with those requiring third-party certification. However, since there were only 9 estimates, they were not able to generate a meta-regression that allows the effects of multiple factors to be investigated simultaneously. Given that a large number of VEP studies have been published in the past decade and meta-regression becomes an increasingly popular tool to evaluate the available evidence in policy actions, I largely increase the number of sampled studies and effect sizes and utilize advanced multiple regression analysis to investigate more comprehensive dimensions of institutional design.

The effect size of interest is the relative environmental performance differential for VEP participants compared with nonparticipants, and is labeled ES, with s_{es} being the associated standard errors. Because the majority of my sampled studies employed multivariate regression techniques to calculate levels of environmental improvement based on different covariates such as VEP membership, emission sources, pollution density, and regulatory or community pressure, I made use of r-based effect sizes to calculate the partial correlation coefficient associated with the regression parameter estimates in these models. The r-based effect size r and its standard error s_r were obtained using the t-scores which test the null hypothesis that the primary studies' population correlation $\rho = 0$ from the formula:

[6] 6 relevant studies were dropped for insufficient statistical details in the reporting of results.

Table 2.1 List of studies included in the meta-sample

No.	Authors	Year	Country[7]	VEP name	No. obs.	Effect size (ES) Mean	S.D.	Min.	Max.
1	Vidovic; Delgado; Khanna	2019	US	Responsible Care	7	0.004	0.020	-0.0175	0.032
2	Nemati; Zheng; Hu	2019	US	ISO14001	3	0.065	0.005	0.061	0.070
3	Kube; von Graevenitz; Loschel; Massier	2019	DE	Eco-Management and Audit Scheme (EMAS)	24	0.006	0.007	-0.012	0.019
4	Papagiannakis; Voudouris; Lioukas; Kassinis	2019	US	ISO14001	4	0.002	0.002	-0.000	0.004
5	Li; Tang; Jiang	2019	CN	ISO14001	12	0.080	0.192	-0.220	0.341
6	McGuire; Hoang; Prakash	2018	US	ISO14001	42	0.005	0.013	-0.021	0.021
7	Baek	2018	KR	ISO14001	1	-0.516	-	-	-
8	Hoang; McGuire; Prakash	2018	US	33/50	24	0.026	0.070	-0.004	0.317
9	Blackman; Golf; Planter	2018	MX	Forest Steward Council	4	0.024	0.015	0.005	0.041
10	McGuire	2014	CN	ISO14001	8	0.110	0.035	0.064	0.160
11	Tung; Baird; Schoch	2014	AT	ISO14001	2	0.045	0.006	0.041	0.049
12	Ferrara; Lange	2013	US	Combined-Heat-and-Power Partnership (CHPP)	2	0.005	0.013	-0.004	0.014
13	Carrion-Flores; Innes; Sam	2013	US	33/50	4	-0.068	0.015	-0.080	-0.052
14	Gamper-Rabindran; Finger	2013	US	Responsible Care	10	-0.021	0.200	-0.073	0.003
15	Henriques; Husted; Montiel	2013	MX	Clean Industry and ISO14001	8	0.056	0.057	-0.028	0.136
16	Brouhle; Graham; Harrington	2013	US	Climate Wise	4	0.027	0.030	0.002	0.071
17	Vidovic; Khanna	2012	US	33/50	3	0.002	0.002	0.000	0.004
18	Matisoff	2012	US	Chicago Climate Exchange	12	0.027	0.044	-0.030	0.092
19	Darnall; Kim	2012	OECD	ISO14001	9	0.138	0.067	0.061	0.256
20	Pizer; Morgenstern; Shih	2011	US	Climate Wise	48	-0.009	0.050	-0.130	0.082
21	Arimura; Darnall; Katayama	2011	JP	ISO14001	34	0.173	0.061	0.090	0.325
22	Tashman; Rivera	2010	US	Business for Social Responsibility	2	0.071	0.100	0.000	0.141
23	Delmas; Montes-Sancho	2010	US	Climate Challenge	2	0.017	0.044	-0.014	0.048
24	Lange	2009	US	Coal Combustion Products Partnership	2	-0.032	0.029	-0.052	-0.012
25	Brouhle; Griffiths; Wolverton	2009	US	Strategic Goals Program	4	0.102	0.031	0.056	0.127
26	Russo	2009	US	ISO14001	1	0.020	-	-	-
27	Arimura; Hibiki; Katayama	2008	JP	ISO14001	6	0.173	0.057	0.087	0.247
28	Innes; Sam	2008	US	33/50	2	-0.005	0.000	-0.005	-0.005
29	Vidovic; Khanna	2007	US	33/50	18	0.010	0.057	-0.074	0.183
30	Barla	2007	CA	ISO14001	16	0.018	0.031	-0.070	0.062
31	Antweiler; Harrison	2007	CA	Accelerated Reduction/Elimination of Toxins Challenge	18	-0.000	0.013	-0.032	0.021
32	Gamper-Rabindran	2006	US	33/50	116	0.005	0.288	-0.660	0.723
33	Rivera; De Leon; Koerber	2006	US	Sustainable Slopes	5	0.043	0.076	-0.046	0.142
34	Potoski; Prakash	2005	US	ISO14001	1	0.037	-	-	-
35	Melo; Wolf	2005	EC	Fair Trade and Rainforest Alliance	2	1.687	0.220	1.532	1.843
36	Potoski; Prakash	2005	US	ISO14001	4	0.258	0.040	0.212	0.304
37	Rivera; de Leon	2005	CR	Certification for Sustainable Tourism (CST)	2	0.007	0.120	-0.078	0.092
38	Rivera; de Leon	2004	US	Sustainable Slopes	1	-0.260	-	-	-
39	Rivera	2004	CR	Certification for Sustainable Tourism (CST)	1	-0.288	-	-	-
40	Melnyk; Sroufe; Calantone	2003	US	ISO14001	18	0.117	0.017	0.070	0.125
41	Welch; Mazur; Bretschneider	2000	US	Climate Challenge	5	0.178	0.227	-0.219	0.353
42	King; Lenox	2000	US	Responsible Care	4	0.023	0.021	0.004	0.053
43	Khanna; Damon	1999	US	33/50	6	0.137	0.071	0.064	0.254
	Overall				502	0.041	0.193	-0.660	1.843

[7] US = United States, DE = Germany, CN = China, KR = Republic of Korea, MX = Mexico, AT = Austria, OECD = the Organizations for Economic Co-operation and Development countries, JP = Japan, CA = Canada, EC = Ecuador, and CR = Costa Rica.

$$r = \sqrt{t^2/(t^2 + df)}$$

$$s_r = \sqrt{(1 - r^2)^2/(n - 1)}$$

Equation 1

However, most original studies did not report t-scores. Instead, they reported parameter estimates and standard errors, so that $t = b_j/s_{bj}$, where b_j is the parameter estimate of interest and s_{bj} is the reported standard error. Studies by Melo and Wolf (2005), Tung et al. (2014), and Baek (2018) resorted to the Mean Difference (MD) test and Analysis of Variance (ANOVA). In these cases, d-based effect sizes were adopted which represented standardized mean differences of environmental performance across VEP participants and nonparticipants. The d values and their associated standard errors were measured with Equation 2:

$$d = (\overline{Y_1} - \overline{Y_2})/S_{Pooled}$$

$$s_d = \sqrt{(n_1 + n_2)/(n_1 n_2) + d^2/2(n_1 + n_2)}$$

Equation 2

where $\overline{Y_1}$ and $\overline{Y_2}$ represent the sample means of the treatment and control group, respectively, and S_{Pooled} represents the pooled within group sample standard deviation as shown below:

$$S_{Pooled} = \sqrt{[((n_1 - 1)s_1^2 + (n_2 - 1)s_2^2)/(n_1 + n_2 - 2)]}$$

Equation 3

So far, I have generated different types of effect sizes from the 43 primary studies. In order to conduct a meta-analysis, all effect sizes must represent the same quantity and be of the same type (Ringquist 2013). Therefore, I first converted all d-based effect sizes and their associated variance to the correlation coefficient r. Eq. 4 shows the formulas for the conversions.

$$r = d/\sqrt{d^2 + (n_1 + n_1)^2/(n_1 n_2)}$$

$$s_r = \sqrt{[((n_1 + n_2)^2/(n_1 n_2))s_d]/\sqrt{[d^2 + (n_1 + n_1)^2/(n_1 n_2)]^3}}$$

Equation 4

According to Ringquist (2013),while r is comparable across studies, it is usually advised to perform Fisher's Z-transformation to obtain accurate weights for each study mainly because of the concern that the variance of correlation coefficient r depends strongly on its value (see Equation 1). Therefore, prior to conducting the meta-analysis, I converted the correlation coefficient r to the r-based effect size Fisher's Z, denoted Z_r:

$$Z_r = 0.5 \ln [(1 + r)/(1 - r)]$$

$$s_z = \sqrt{1/(n - 3)}$$

Equation 5

Since the sign of the primary studies' original coefficient was removed when calculating the p-values and t-scores for coefficient r, I determined the sign of Z_r by whether the coefficient was indicating a positive correlation between program participation and environmental

performance. That is to say, coefficients reflecting positive program impacts on environment were coded as positive effect sizes, and vice versa. Figure *2.1* displays the ordered reported effect sizes. For each effect size, a symmetric 95% confidence interval is denoted by a vertical bar. As shown in the figure, most reported effect sizes are small. Nevertheless, the majority of the interventions tend to produce positive effects. From the 502 effect sizes, only 35 percent of them are smaller than zero, whereas almost 65 percent are larger than zero. Table *2.1* lists more specific details of the primary studies and effect sizes included in this review.

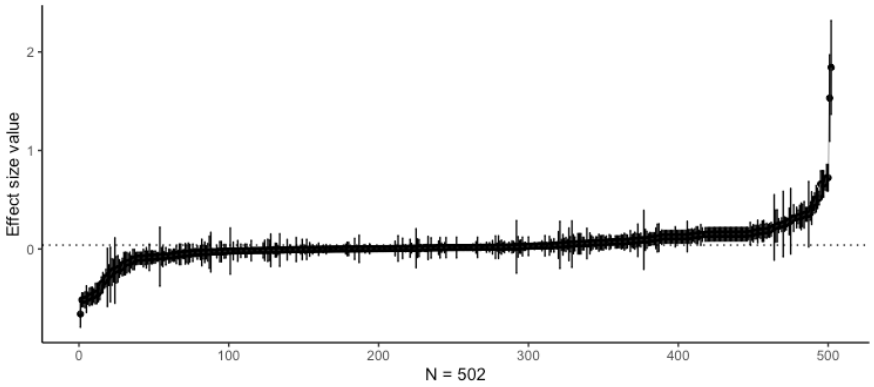

Figure 2.1 Reported effect sizes

2.4.3 Coding the Variables

Importantly, I collected information on the institutional designs of each study's voluntary program(s), which resolves my key question regarding whether the effectiveness of VEPs is influenced by the design of the programs. I measured the characteristics of VEPs using four sets of variables. First, I created two dummy variables identifying the monitoring regime of the programs. Dummy variable, *mon_external*, equals 1 if the effect size comes from VEPs with an external-audited monitoring regime, otherwise equals 0 when the effect size comes from VEPs that are based on self-reports. Similarly, I created a dummy variable identifying whether the effect size comes from programs that require members to disclose their environmental records to the public (*disclose*). Third, I coded whether the effect size comes from programs that provide educative or technical assistance to VEP participants (*assistance*). Finally, I created three dummy variables identifying the effect sizes from programs sponsored by solely government (*spr_gov*), solely industry associations (*spr_ind*), or co-sponsored by both government and industry associations (*spr_coop*). The reference category is the effect sizes from VEPs sponsored by third-party organizations.

I also extracted the data necessary for moderator variables used in the meta-regression models. First, even though all the estimates extracted for my analysis were based on environmental performance data, different measures were used in the primary studies. A majority of the studies measured VEP outcomes with the level of pollution reduction, but there are also other types of measures. For example, McGuire (2014) and Potoski and Prakash (2005b) looked at regulatory compliance records of the VEP participants; Arimura et al. (2011), Blackman et al (2018), McGuire et al.(2018), Melnyk et al. (2003), Tashman and Rivera (2010) and Tung et al.

(2014) explored whether VEPs motivate participants to adopt some specific pollution abatement or environmental conservation practices. Moreover, studies that examined environmental innovations include Brouhle et al. (2013), Carrion-Flores et al.(2013), Kube et al. (2019), Li et al. (2019), and Papagiannakis et al. (2019). I coded the effect sizes based on the outcome measures used by primary studies. These measures were divided into two categories. One of them is related to programs' direct impacts on the environment, such as pollution emission, resource use, and compliance records. [8] The other category is the indirect outcome (*dv_indirect),* which do not directly measure the environmental impact but are more associated with businesses' routine operation and management. This category includes adoption or environmental management practices, environmental patents, or innovations, which help reduce pollution in theory but do not measure the end results on the environment. *dv_indirect* is coded 1 for indirect measures as the outcome, and 0 for direct measures. [9]

Moreover, while proponents hope that VEPs can improve the environmental performance of all firms, it might be possible that VEPs work better among some firms rather than the others. A global view of VEP's performance can capture this question. For example, whether VEPs work better in developing or developed countries? This study examines original studies from a broad landscape of multiple countries. A dummy variable, *developing*, was included to control the country effects based on the level of economic development. It scores 1 if the effect size comes from studies that focus on developing countries, and zero otherwise.

As for the estimation method, VEP scholars generally have the consensus to utilize two-stage estimation procedures to address the endogeneity issues associated with VEP participation. Since the participation of VEPs is voluntary, members of VEPs may differ systematically from the broader population of interest for which our measures of VEP efficacy are calculated. For example, participants of VEPs might be those who keep outstanding environmental records or those who show dirty records but are willing to greenwash their reputation. These unmeasured factors result in an error term that is associated with the participation decision of the VEP participants, potentially leading to a biased understanding of the impact of VEP characteristics on efficacy. However, some studies disregarded the endogeneity between VEP participation and environmental outcomes. This review is not limited to studies that use two-stage estimation methods; rather, it also includes analyses with a normal regression approach or difference of means tests to demonstrate whether the estimation method would be one of the causes of different findings of VEP efficacy. Specifically, I created a moderating variable to identify effect sizes where two-stage estimation techniques are adopted (*twostage*). The excluded category is

[8] Since compliance records are usually directly related to pollution releases, this measure is categorized as a direct outcome.

[9] In addition, other studies have noted that VEPs can be effective at achieving some "important but hard to quantify soft effects", such as changes in attitudes or management practices, other than improving participants' quantitative change in pollution emission or the number of compliance citations (Morgenstern and Pizer 2007). These "soft effects" are examined in a handful of my sample studies that use survey results. So, the effect sizes from these studies tend to be positive and larger. Also, considering the respondents are often the ones in charge of or related to the operation of VEPs, it is expected that surveys tend to give more positive and desirable results regarding the effectiveness of VEPs. As another control of outcome measures, I coded whether effect sizes come from studies that use survey results to measure program efficacy (*survey*). However, since the bias in the survey is a result of membership in the VEPs, this is a bad control in regression. Therefore, *survey* is not included in the meta-regression models.

single-stage estimation without any ex-post control for endogeneity.

Table 2.2 Description of variables included in the meta-regression model

Variable	Description	Summary statistics		
		No.obs	Mean	St. dev.
Dependent variable				
Effect size (*ES*)	VEP participants' improvement in environmental performance compared with nonparticipants	502	0.039	0.191
Program design				
mon_external	Dummy =1, if the effect sizes are from programs in which external auditing is required; and zero if the programs only require self-monitoring.	502	0.311	0.464
disclosure	Dummy = 1, if the program incorporates the requirement of public disclosure and zero otherwise	502	0.551	0.498
assistance	Dummy = 1, if the program offers educative assistance to its members and zero otherwise	502	0.429	0.495
Program sponsorship				
spr_gov	Dummy = 1, if the program is sponsored by a government body and zero otherwise	502	0.661	0.474
spr_ind	Dummy = 1, if the program is sponsored by an industry association and zero otherwise	502	0.054	0.226
spr_coop	Dummy = 1, if the program is co-sponsored by government agencies and industry associations, and zero otherwise.	502	0.054	0.226
Characteristics of outcome measure				
dv_indirect	Dummy = 1 for effect sizes from models that use indirect measures related to environmental output, such as management practices, and zero for measures like pollution emission, resource use, or compliance records	502	0.343	0.475
Empirical model and data				
twostage	Dummy = 1, if the outcome corresponds to a two-stage estimation approach and zero otherwise	502	0.695	0.461
Context of the study				
developing	Dummy =1 if the effect sizes from studies focused on developing countries, and zero otherwise	502	0.076	0.265
Control variables of the study				
ctr_pollut	Dummy = 1, if the study includes variables controlling for pollution records of the firm, and zero otherwise	502	0.774	0.418
ctr_reg	Dummy = 1, if the study includes variables controlling for the regulatory pressure of the firms, and zero otherwise	502	0.535	0.499
Other characteristics of the study				
med_splyear	The median sample year of the study	502	1998.75	5.462
time_span	The time span (in years) of the data covered in the study	502	6.960	4.967

For each effect size, I recorded its associated VEP's name, environmental outcome measure, estimation method, model covariates, sample size, time span, and VEP effect parameter together with its standard error. From the primary studies, I first constructed two dummy variables about model covariates to account for the quality of original studies: whether the effect size is drawn from the estimation model that included variables controlling for the regulatory pressure of the firms (*ctr_reg*) and/or controlling for pollution records of the firms (*ctr_pollut*). I introduced another set of variables, *med_splyear* and *time_span*, to respectively represent the median sample year of the study and the time span of the data covered in the study. Moreover,

for each study, I also coded the first three authors, publication year, journal name, page number, and the type of data (cross-sectional, time series, panel, experimental) for records. [10]

2.5 Univariate Meta-analysis and the Replication of Darnall and Sides (2008)

My first objective is to establish the sign and significance of the impact of VEPs on environmental stewardship. This requires calculating an average effect size for all sample studies. Table *2.1* suggests that positive environmental effects prevailed in existing VEP studies. In particular, 34 out of the 43 studies reported, on average, a promising effect of environmental improvement.[11] I performed a univariate meta-analysis of the estimated effect sizes. To combine together the effect sizes, fixed-effects or random-effects models are commonly used in meta-analysis (Beltrán, Maddison, and Elliott 2018; Ringquist 2013). Because my sample studies vary in terms of both the estimation techniques as well as the underlying universe of population, the assumption of fixed effects that all studies pose a common effect size is implausible. Therefore, I used R to calculate an average effect size from the 502 calculated effect sizes with a random-effects model. Table *2.3* reports the statistics. Also reported are results from different subsamples where observations have been put into categories according to the program designs. The table additionally reports the between study variance τ^2, the 90% confidence intervals, the I^2, and the Q-statistic.[12]

The average effect size from the random effects meta-analysis is 0.034 with a 95 percent confidence interval of [0.020 – 0.049] (the random effects variance component τ^2 = 0.028). This average effect size can be interpreted as the average partial point biserial correlation between the adoption of VEPs and environmental performance on standardized tests. This means that across all 18 programs, VEP participants demonstrated a 3.4 percent stronger environmental performance than nonparticipants. The confidence interval results suggested that participants' performance improved between 2.0 and 4.9 percent more than VEP nonparticipants. While the effect is distinguishable from zero (Z = 4.56, p = 0.000), the magnitude of the effect is small, suggesting that VEPs have a small positive effect on firm environmental achievement.

---

[10] In the initial search, more than 40 observable differences across studies and estimates were coded. Some of them are not very informative, because they identify only one or two specific observation or they hardly vary over the entire dataset. In other cases, there is a high degree of collinearity with other conditioning variables. This obviously complicates the interpretation of the results, and can only be avoided when a larger number of primary studies become available.

[11] However, there is significant within and between study variation as revealed by the columns recording the standard deviation (S.D.) of the effect sizes and the minimum (Min.) and maximum (Max.) effect sizes. Estimates range from the -66.0% environmental degradation found by Gamper-Rabindran (2006) to the +184.3% environmental improvement reported by Melo and Wolf (2005).

[12] The I^2 index is a more recent approach to quantify heterogeneity in meta-analyses. I^2 provides an estimate of the percentage of variability in results across studies that is due to real differences and not due to chance. Cochran's Q test is the traditional test for heterogeneity in meta-analyses. Based on a chi-square distribution, it generates a probability that, when large, indicates larger variation across studies rather than within subjects within a study. A limitation of Cochran's Q test is that it might be underpowered when few studies have been included or when event rates are low. Therefore, it is often recommended to adopt a higher P-value (rather than 0.05) as a threshold for statistical significance when using Cochran's Q test to determine statistical heterogeneity.

As for the subgroup average effect sizes, participation in external-audited programs was associated with an 8.0 percent improvement in environmental performance over nonparticipants, and self-reporting regimes were associated with only 0.8 percent environmental improvement. Surprisingly, though public disclosure showed a positive association with improved environmental performance, participants in programs without public disclosure is shown to have a much larger percent increase in performance. Educative assistance also showed an unexpected outcome: participants in VEPs that do not offer any educative or technical assistance demonstrated a slightly stronger environmental performance than otherwise. Finally, participation in third-party sponsored programs was associated with 10 percent improvement in environmental performance over nonparticipants. Though there was inclusive evidence regarding the effects of other sponsorship types, the primary univariate results found greater efficacy of collaborative sponsorship compared with independent sponsorship by government or industry associations. Besides, the results also suggested participants failed to improve their environmental performance in industry-sponsored programs over nonparticipants.

Table 2.3 Meta-analysis: summary statistics

Sample	Random effects model (A1)					
	N	Summary statistic	95% conf. interval	τ^2	Q-stat	I^2
Overall						
Program outcome (43)	502	0.034***	[.020, .049]	0.028	19447	97.4
Type of monitoring regimes						
External-audited (23)	182	0.080***	[.060, .100]	0.022	2448	92.6
Self-reporting (16)	320	0.008	[-.002, .027]	0.030	16999	98.1
Existence of public disclosure						
Disclosure (18)	327	0.006	[-.0013, .024]	0.029	17077	98.1
No disclosure (25)	175	0.088***	[.067, .109]	0.022	1826	90.5
Existence of educative assistance						
Assistance (27)	110	0.015	[-.013, .043]	0.029	610	82.1
No assistance (16)	392	0.040***	[.023, .057]	0.029	18299	97.9
Type of sponsorship						
Industry-sponsored	28	-0.001	[-.015, .015]	0.002	225	88.0
Government-sponsored	300	0.006	[-.014, .026]	0.031	16688	98.2
Third-party sponsored	143	0.101***	[.076, .126]	0.013	1767	92.0
Collaboratively sponsored	31	0.018	[-.007, .044]	0.000	29	0.0

Note: Estimation results with standard errors in parentheses. Significance is indicated by *, ** and *** for the 10, 5 and 1% levels, respectively.

To draw a comparison between the sample of my study and that of the work presented by Darnall and Sides (2008), I performed another meta-analysis using only observations in my sample that are from papers included in their analysis. Since their work was published more than a decade ago and stricter inclusion and exclusion criteria were imposed, only 9 studies were

sampled. Darnall and Sides (2008) followed the traditional advice of one effect size for one study, and the total of effect sizes is equal to the number of original studies they included. With no access to the statistical data they extracted from the 9 original studies, I applied random Monte-Carlo simulation trying to reproduce their results. Based on the descriptions of the point estimates they chose to include in their study, I first identified 53 possible effect sizes and associated effect size standard deviations from the 9 studies to form the simulation sample set. I conducted 500 runs in total. In every run, one single effect size from each study were randomly drawn. Then these draws were grouped as one single meta-sample to produce the results. Figure 2.2 shows the probability density of the simulations. The median and the mean of my simulated distribution is 0.0538 and 0.0547, respectively. 90% of the results fall in the range between 0.010 and 0.099. 3.8% of the results fall below 0 which meets Darnall and Sides's (2008) conclusion that VEP participants do not improve their environmental performance over nonparticipants.[13]

From this overall review, it seems that VEP participants are more likely to improve their environmental performance better than nonparticipants, and a combination of institutional designs consisted of external-auditing, educative assistance, and third-party sponsorship should be expected to provide the highest level of environmental outcome. However, this is an unconditional estimate of the effects of VEPs. It may mask important heterogeneity in effect size estimates across studies. The large values of I^2 and the Q-statistic motivate me to consider other sources of heterogeneity, and more will be investigated using a more comprehensive meta-regression analysis.

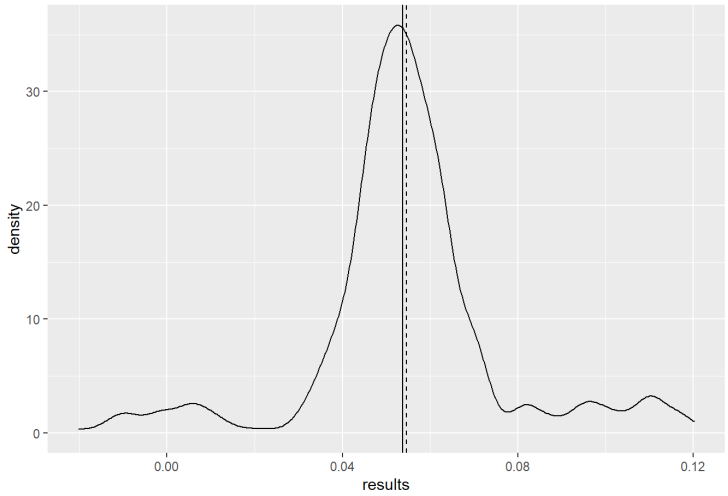

Figure 2.2 Density plot of Monte-Carlo simulation of Darnall and Sides's (2008) sample

[13] Generally speaking, this seems to be a contradictory result when compared to Darnall and Sides's (2008) earlier study. Part of the reasons might be the difference in ways of extracting statistical results from primary studies. In their sample, effect sizes of King and Lenox (2000) and King, Lenox and Terlaak (2005) were extracted based on the means of the two coefficients in each study. This suggests that some information of the original data was lost. Especially for King, Lenox and Terlaak (2005), the two coefficients show different signs of VEP effects, but the positive effects were removed by the averaging operation. Moreover, it is also possible that their study just happened to draw effect sizes that lead to a negative finding of VEP effects.

2.6 Meta-Regression

Table *2.1* suggests that positive environmental effects prevailed in the sampled VEP studies. In particular, 34 out of 43 studies reported, on average, a promising VEP effect of environmental improvement. [14] To understand cross-study differences in these estimated effects, I adopted meta-regression techniques to evaluate the potential causes. Meta-regression is able to examine the heterogeneity across program designs as my hypotheses indicate. The dependent variable is effect size ES_i extracted and calculated from each study j, and the predictor variables are different dimensions of institutional designs of research interest such as the categories of monitoring mechanisms (*mon_external*), information disclosure (*disclosure*), educative assistance (*assistance*), and sponsorship (*spr_gov, spr_ind, and spr_coop).* A set of moderator variables (X_i) as described in Table *2.2* have also been identified and coded as possible sources of heterogeneity in the studies on VEP efficacy. It should be noted that if one accounts for all observable differences, the degree of multicollinearity becomes prohibitive, so only a limited group of conditioning variables was selected. Table *2.2* provides the descriptive statistics, and the regression model is structured as Equation 6:

$$
\begin{aligned}
Effect\ Size\ (ES_{ij}) \\
&= mon\_external_{ij} + disclosure_{ij} + assistance_{ij} \\
&+ mon\_external_{ij} \times disclosure_{ij} \\
&+ spr\_gov_{ij} + spr\_ind_{ij} + spr\_coop_{ij} + X_{ij} + e_{ij}
\end{aligned}
\qquad \textit{Equation 6}
$$

The meta-regression models were estimated using all 502 effect sizes from 43 primary studies. This data structure clearly violates the assumption of meta-regression that all effect sizes are independent. In a traditional meta-regression, observations are single effect sizes from individual primary studies. For studies producing multiple effects, it is common to average the effects within studies. This averaging, however, may eliminate meaningful variations in effects (Ringquist 2005). For example, Blackman et al. (2018) conducted several models for VEP outcomes without controls for firm size and community pressures, but another set of models that do contain these controls. Similarly, Brouhle et al. (2013) examined the effects of VEP both in a naïve OLS model and a two-stage treatment effects model. The effect sizes calculated from these different model specifications reflect meaningful variation with respect to study designs. However, including these effect sizes may produce two major obstacles. First, a few studies that produce many effects may dominate the analysis, calling into question the generalizability of the results. Second, multiple effect sizes calculated from the same study would be correlated, violating the independence of observations assumption that underlies regression analysis.

[14] However, there is significant within- and between-study variation as revealed by the columns recording the standard deviation of the effect sizes and the minimum and maximum effect sizes. Estimates range from the -66% environmental degradation found by Gamper-Rabindran (2006) to the +184.3% environmental improvement reported by Melo and Wolf (2005).

This study accounts for these complications by estimating two sets of regression models.[15] First, I performed robust variance estimation (RVE) (Hedges, Tipton, and Johnson 2010; Tipton and Pustejovsky 2015), which is essentially a random-effects meta-regression model with clustered robust parameter variances. In a meta-analysis, the overall effect size is usually estimated through a weighted mean of the observed effect sizes. However, to calculate the sampling variance of this mean effect, the covariance matrix of estimation errors is needed, which is most likely unknown. Hedges et al. (2010) proposed to calculate the crossproduct of the residuals within each study as a crude estimate of the covariances for that study. In this way, the robust sampling variance estimate is acquired without accurate estimates of the covariance matrix for each study. This is a most recently suggested method for handling dependent effect sizes in meta-analysis. First, because RVE adjusts the standard errors and does not require accurate knowledge of the within-study covariates, the approach can be applied to any type of dependence (Moeyaert et al. 2017). This means that dependence arising from multiple sources simultaneously, "including multiple measures, multiple treatment groups, and multiple time points can be accommodated simultaneously with the use of RVE" (p.562). Second, although theoretically, the inverse variance provides the most efficient weights for the effect size estimator, the RVE can be applied using any type of weights for the effect size estimates. The use of less efficient weights that arises from an incorrect choice of meta-analytic models will not compromise the results of a meta-analysis, as RVE still provides accurate estimates of standard errors. [16] Later, Tipon (2015) introduced small sample adjustment for RVE which is demonstrated to yield accurate results with as few as 20-40 studies. I employed the Tipton adjustment in the RVE-based meta-regression. Data analysis used R software. The "robumeta" and "clubSandwich" package were used to assess the RVE models.

Second, I estimated a multilevel meta-analysis model (Van den Noortgate et al. 2013). In general, multilevel analysis is used when data are structured at different levels, and variations of each level are to be considered (Geeraert et al. 2004). Recall Figure *2.1* which shows that the effect sizes vary. This variation can be situated on at least three levels. The first source of variation is sampling variance. Each effect size is a "pooled" result of a group of objects (e.g., firms, plants, farms, etc.), and it is very likely that the program has different effects on each of the objects. A second source is that studies often use various measures or designs to evaluate program effects. Effect sizes, therefore, differ according to their model or research design. Finally, studies differ in the characteristics of the VEPs they are evaluated and in other study-level characteristics, such as the context, the target population, and the point in time. In all, three different levels of variation can be taken into account: sampling variance for each effect size which is directly extracted from primary studies (level 1), within-study variance due to different model specifications or sample designs (level 2), and between-study variance because of VEP features and population of interest (level 3) (Borenstein et al. 2009; Geeraert et al. 2004; Moeyaert et al. 2017). Accordingly, I conducted a three-level meta-regression model as follows:

---

[15] Meta-regressions in economics have been estimated using a variety of estimators ranging from simple ordinary least squares (OLS) to generalized least squares with various alternative weighting procedures (e.g., fixed and mixed effects model, and the robust Huber-White approach) as well as hierarchical level models. These estimators have their own respective pros and cons (see Also Abreu et al. 2005). OLS is obviously inefficient because it discards the information on the estimated standard errors that can be taken from the primary studies and disregards the autocorrelation that may result from sampling multiple estimates from the same primary study.

[16] A more detailed description of this approach can be found in Hedges et al. (2010).

$$ES_{ij} = mon_{external_{ij}} + disclosure_{ij} + assistance_{ij} + mon_{external_{ij}} \times disclosure_{ij} + spr_{gov_{ij}} + spr_{ind_{ij}} + spr_{coop_{ij}} + X_{1ij} + X_{2ij} + u_j + r_{ij} + e_{ij} \quad \textit{Equation 7}$$

where X_{1ij} represents covariates (including *twostage*, *dv_indirect, ctr_pollut* and *ctr_reg)* that explain variation across effect sizes within a study (level 2), and X_{2ij} refers to the covariates (including *developing*, *time_span* and *med_year*) that explain the variation across studies (level 3). u_j is the residual for study j and is typically assumed to follow a normal distribution with a mean of zero and a variance σ_u^2. r_{ij} is the residual for effect size i within study j, typically assumed to follow a normal distribution with a mean of zero and variance σ_r^2. I used the R package "metaSEM" (Cheung 2019) to conduct the three-level model.

RVE and the multilevel model handle the statistical dependence created by multiple effect size estimates from the same study with minimal loss of statistical information from primary studies. The first main difference between the two models is that RVE typically intends to adjust standard error estimates and only provides an estimate of the total variance, whereas the multilevel model includes additional random-effect variance component estimates to account for the dependency (Fernández-Castilla et al. 2020; Park and Beretvas 2019). Another concern of using RVE is that its regression parameter estimates (but not their variances) weight all effect sizes equally. With my data, this means that the 4 largest studies generating 240 effect sizes would exercise nearly as much influence over the meta-regression parameter estimates as do the other 39 studies (262 effect sizes). With such a large variation in the number of effect sizes generated by the primary studies, the multi-level model is preferred.

2.7 Results and Discussion

Table *2.4* presents the meta-regression results. Statistics in the first three columns come from RVE whereas the next three come from the multilevel regression models. To begin with, intercept-only models (1) and (4) show the unconditional mean effect sizes across all primary studies. The mean effect size coefficient was roughly 0.030 in the RVE model and 0.049 in the multilevel model. According to the rules of thumb established by Cohen (1992), in both cases, these estimates are of small magnitude, yet they are statistically significant. Hypothesis testing for this coefficient suggests a rejection of the null hypothesis of zero at the $p < 0.01$ level. Therefore, in general, the empirical VEP efficacy literature shows a statistically significant and positive relationship between VEP participation and environmental improvement. The remaining models attempt to explain more complex relationships between VEP efficacy and other covariates. I will first summarize and discuss the factors of program design variables including monitoring, disclosure, and educative assistance. Then I will introduce the sponsorship variable and investigate its impacts in more detail.

Table 2.4 Meta-regression results predicting the VEP outcomes

	Random Variance Estimation			Multilevel Modeling		
	(1)	(2)	(3)	(4)	(5)	(6)
Baseline outcome						
Constant	0.030 ***	-0.016	-0.060	0.049 ***	-0.002	0.059
	(0.013)	(0.041)	(0.051)	(0.016)	(0.045)	(0.076)
Program design						
External auditing		0.098 ***	0.147 **		0.101 ***	0.163 **
		(0.027)	(0.040)		(0.037)	(0.075)
Public disclosure		-0.001	-0.009		0.003	0.015
		(0.019)	(0.027)		(0.032)	(0.047)
External auditing × Public disclosure		-0.076 **	-0.120 **		-0.089 *	-0.143 *
		(0.033)	(0.040)		(0.046)	(0.079)
Educative assistance		0.030	0.052 *		0.042 *	0.065 **
		(0.022)	(0.025)		(0.024)	(0.028)
Sponsorship						
Government sponsorship			0.049			0.042
			(0.036)			(0.068)
Industry sponsorship			0.008			-0.006
			(0.035)			(0.070)
Cooperative sponsorship			0.057			0.078
			(0.044)			(0.077)
Level 2 (within-study) covariates						
Intermediate outcome		0.013	0.012		0.010	0.011
		(0.017)	(0.018)		(0.018)	(0.018)
Two-stage model		0.056 ***	0.062 ***		0.052 **	0.058 ***
		(0.019)	(0.022)		(0.021)	(0.023)
Control of pollution records		-0.026	-0.038		-0.038	-0.052*
		(0.034)	(0.035)		(0.026)	(0.028)
Control of regulatory pressure		-0.003	0.007		-0.000	0.013
		(0.016)	(0.017)		(0.017)	(0.018)
Level 3 (between-study) covariates						
Developing countries		-0.045	-0.053		-0.023	-0.028
		(0.035)	(0.040)		(0.031)	(0.031)
Rescaled time span (in years)		-0.022	-0.012		-0.025	-0.013
		(0.078)	(0.078)		(0.036)	(0.036)
Rescaled median of sample year		-0.003	-0.017		-0.018	-0.036
		(0.027)	(0.029)		(0.047)	(0.048)
Number of observations	502	502	502	502	502	502
Number of studies	43	43	43	43	43	43

Note: Estimation results with standard errors in parentheses. Significance is indicated by *, ** and *** for the 10, 5 and 1% levels, respectively.

2.7.1 Effects of Program Design on VEP Efficacy

The central question for the meta-regression models is whether the estimated baseline outcomes of VEPs would change appreciably under different institutional design choices. In this section, I will discuss the effects of monitoring, disclosure, and assistance, and pay specific attention to models (2) and (5) in Table *2.4*. For example, based on the result of the preferred multilevel model (5), when there are no disclosure rules (public disclosure = 0, external auditing = 1), the effect of external auditing, compared with self-reporting, on VEP efficacy was approximately 0.101; whereas when there do exist disclosure rules (public disclosure = 1, external auditing =1), this effect was decreased to 0.012. Fist, this means no matter the existence of public disclosure rules, external auditing has significant positive effects on VEP efficacy. This confirmed my first hypothesis that with a stronger institutional design such as external auditing, VEP participants are more likely to improve their environmental performance and increase program efficacy.

However, public disclosure rules decreased the effect of external auditing on VEP performance, which showed the oppositive of my hypothesis 2 that argues a positive effect of public disclosure on VEP efficacy. According to the results of models (2) and (5), in a self-monitored VEP (external auditing = 0), the parameter estimates of the public disclosure variable are always negative. While evaluating the outcomes of external-auditing VEPs (external auditing =1), however, public disclosure was associated with 7.7 to 12.9 percent degradation in program performance. These findings did not support my hypotheses 2 and 3, which together state that public disclosure, through diminishing information asymmetries between firms and external stakeholders, is a strong institutional design to encourage more environmental behaviors. In contrast, firms can have great discretion in making such disclosures, and those disclosures they made are of different forms and of varying levels of stringency and quality. For example, the Certification for Sustainable Tourism (CST) in Costa Rica (Rivera 2004) and European Union's Eco-management and Audit Regulation (EMAS) (Kube et al. 2019) have both external audits and public disclosure rules. CST requires program participants to publish their external certification results and ratings online, though the disclosed information could be mostly general without considering too many details. Whereas EMAS requires its participants to compose an environmental statement by themselves and identify a third party to have the statement accredited before disclosing it to the public. These disclosure rules increase the flow of information to the public, but the current debate questions their functionality. Is the disclosed information understandable to the intended public audience? Do firms strategically disclose environmental information to conceal the negative aspects of their environmental performance? And what makes the effect of public disclosure different from that of external auditing?

The major difference between the designs of public disclosure and external auditing might be their intended audience: external auditing supplies new information to business managers whereas public disclosure disseminates existing information to firms' stakeholders. From a practical perspective, external auditing is directly related to the inside of firms. External auditing enriches firms' knowledge about their own pollution and abatement opportunities, which can be the key means by which an institutional design spurs pollution abatement. As a comparison, public disclosure influences firm behavior indirectly through enhancing external pressures placed on them by a variety of actors including community, consumers, and financial markets. That is to say, in a public disclosure regime, the creation of a positive image motivates

firms to cut emissions. Therefore, participants of a public disclosure program are more likely to withhold facts that do not reflect favorably on them, which meets Lyon and Maxwell's (2011) definition of "greenwash".

Does public disclosure tend to suffer more from greenwashing? Concerns surrounding disclosure rules regarding "greenwash". As shown in Kim and Lyon's (2011) study of the U.S. Department of Energy's Voluntary Greenhouse Gas Registry, electric utilities engage in highly selective reporting of positive environmental results, while withholding information on negative results. Furthermore, they found that in the aggregate, utilities who were involved in the voluntary disclosure program increased emissions over time while non-participants actually decreased emissions. In this case, information cannot be assumed to be shared truthfully. Unless the authenticity of each firm's information can be verified, firms may divulge false information for their own benefit (Mishra, Raghunathan, and Yue 2007). These information distortions may reduce the benefits of public disclosure rules, thus harming their effects on VEP outcomes.

Apart from auditing and disclosure, the meta-regression results found a weak positive correlation between educative assistance and VEP outcomes. Significant positive results were found in model (5), although the significance was lost in model (2). The findings did not provide strong support for my hypothesis 3, which states that educative assistance, as a weak institutional design feature, would not necessarily relate to program effects. Rather, they indicated that the assistance tool, though as a weak institutional design with much lower level of incentives provided, can impact the pro-environmental behavior of VEP participants. The assistance tool can potentially facilitate innovative changes and save the informational costs for firms to improve their environmental practices.

2.7.2 Effects of Sponsorship on VEP Efficacy

Models (3) and (6) in Table *2.4* shows the results of regression models that took into account the programs' sponsorship types. In these two regressions, third party sponsored VEPs are the reference group of sponsorship. The coefficients represent the average difference between third-party sponsored VEPs, and other programs characterized of government, industry, and cooperative sponsorship. The parameter estimates suggested that the mean efficacy of third-party sponsored VEPs was not statistically different from other types of VEPs even at the 10% level. Rather, statistically, cooperative and government sponsored VEPs were likely to improve environmental performance more than the third-party ones. These findings did not support my hypothesis 5, which states that third-party sponsored VEPs would have improved program performance more than the ones sponsored by industry associations or government agencies.

To test the final hypothesis of 6 that VEPs collectively sponsored by industry associations and government agencies will outperform programs respectively sponsored by these two types of organizations, an F-test of the joint hypothesis was performed. By comparing the squared residuals from the general model where all the types of sponsorship are considered (column 3 and 6 in Table *2.4*) and the restricted model where the null is supposed to be true and sponsorship variables are removed (columns 2 and 5 in Table *2.4*), the F-test revealed how much the fit of the regression increased with the adding of sponsorship variables. The joint F-test with the restrictions of three sponsorship variables resulted in $F(3,486) = 1.573$ with p-value = 0.194 for the multilevel model and $F(3,486) = -54.86$ with p-value = 1. The null hypothesis was not

rejected at the 5% level since the p-value is larger than 0.05. This implies that the mean efficacy of the total four types of VEPs was all equal, or that sponsorship had no effect on VEP effects on program improvement.[17] These findings did not support hypothesis 6, which states that cooperative VEPs are stronger than industry or government sponsored programs in improving program performance. Combined, these findings offer some support that sponsorship alone is not associated with program efficacy; however, program designs significantly impact program outcomes. In other words, program designs, rather than the feature of sponsorship, might be the reason why some VEPs outperform the others.

2.7.3 A Brief Discussion on the Control Variables

There are some intriguing results on the control variables. First, studies with the more comprehensive two-stage models reported 5 or 6 percent larger VEP effects. Since a two-stage estimation approach is intended to correct for sample selection bias that results from firms nonrandomly selecting into VEPs, it tends to report, if anything, a downward bias. Considering the significant positive coefficients of the two-stage variable, my results indicated a strong support of the preliminary findings that VEPs are associated with positive environmental impacts. Second, though only significant results were reported in model (6), controlling firm environmental records before the adoption of VEPs was more likely to be associated with weaker VEP effects. This control tends to take care of the selection and omitted-ability bias in primary studies' estimated VEP efficacy and might reduce the significance of VEPs in improving environmental performance. In addition, the coefficients of intermediate measure of program outcome did not suggest any solid evidence that VEP participants are less likely to produce actual quantitative change in pollution or abatement compared with those intermediate changes in management practices. Indeed, the consistent positive signs of the coefficients indicated an optimistic outlook of VEPs that these programs may contribute to process changes in routine operation which might show performance improvement in a longer term. Besides, the results did not support the argument that developed countries outperform developing countries in VEP performance. With proper designs in place, the VEPs might be able to help address numerous environmental concerns in developing countries.

Another issue that warrants further investigation is the negative effect of VEP duration.

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[17] If the null if of the form, $H_0: \beta_{spr\_1} = \beta_{spr\_1} = \beta_{spr\_1} = 0$, then the F statistic can be written in the following way:

$$F_0 = \frac{(SSR_r - SSR_{ur})/q}{SSR_{ur}/(n-(k+1)}$$

where SSR_r stands for the sum of the residuals of the restricted model and SSR_{vr} is the same for the unrestricted model. N is the number of observations; k is the number of independent variables in the unrestricted model and q is the number of restrictions (or the number of coefficients being jointly tested). We are restricting the general model by imposing supposing that the null is true and removing variables from the model. Thus, the difference ($SSR_r - SSR_r$) is telling us how much bigger the residuals are in the model where the null hypothesis is true. If the residuals are a lot bigger in the restricted model, then SSR_r will also be big. When the residuals are bigger, we know that this means the fit of the regression is worse. Thus, SSR_r is big when the restriction makes the fit of the regression a lot worse which is exactly when we would question the null hypothesis. If these variables really had no predictive power, then removing them should not affect the residuals.

This refers to both the duration of general VEPs and the duration of one specific VEP. This aspect is reflected in the results by the negative sign associated with the time trend variables referring to the median sample year and the time span. Reasons for the negative signs may be that VEPs suffer from a duration problem or due to spillover effects as mentioned by scholars such as Matisoff (2015). Though the conclusions are not strongly supported by the significant results, future studies may benefit by investigating the duration effects of VEPs on firm behavior change.

2.8 Sensitivity Analysis

While meta-regression statistics in the main manuscript have been presented to show the respective association between VEPs and environmental improvement, caveats should be added. First, due to selection effects, the findings of these published studies may not be an adequate representation of the population of all possible study results. This type of selection effect is usually referred to as "publication bias" and includes the effects of self-censoring of authors with respect to undesirable or implausible results, and the possible tendency of journal reviewers and editors to be favorably disposed towards the publication of statistically significant results. Second, it might be well possible that a few studies or effect sizes yield effects that are outlying or extreme in the sense of being rather separated from the rest of the data. These outlying or extreme effect size values would distort the conclusions, and consequently, the interventions may yield even opposite effects in some other scenarios. To test the validity and robustness of my results, a series of outlier and influence diagnostics are also produced.

2.8.1 Publication Bias

Publication bias was assessed using both the funnel plot and Egger's statistical test (Egger et al. 1997). The funnel plot, as shown in Figure *2.3*, depicts the observed effect size estimates against their corresponding standard errors. The plot is hypothesized to show the symmetric distribution of estimated effect sizes that centers around the pooled effect size (the stripped line). When publication bias is present, the funnel would look asymmetrical, because only small studies with large effect sizes are published, while small studies without a significant and large effect would be missing. Figure *2.3* is asymmetric. First, studies at the higher end of the plot slightly stretch to the left hand. Since studies with effects toward the higher end of that range are more likely to be larger studies with statistically significant results, this tendency has the potential to produce a downward bias in the assessment of VEP efficacy.

Second, at the lower end, small studies with low effect size are missing in the bottom-left corner of the plot, and this asymmetry is primarily driven by a single small study with two high effects in the far bottom-right corner. The funnel plot indicates publication bias. This conclusion is confirmed by Egger's test, which statistically investigates the asymmetry of the funnel plot by determining whether the intercept deviates significantly from zero in a regression of the standardized effect estimate against its variance. The estimated constant for the meta-sample was 0.005, with a p-value smaller than 0.05. This means that there is an asymmetry in the funnel plot, and this asymmetry could have been caused by publication bias.

Moreover, it can be drawn from the funnel plot that there is a substantial amount of

observations outside the 95 percent contours. Consider the publication bias caused by the two effect sizes at the bottom right. There is a high possibility of extreme effect size values in the meta-sample. As the main objective of a meta-analysis is to provide a reasonable summary of the effect sizes of a body of empirical studies, the presence of such outliers may distort the conclusions of a meta-analysis. If the conclusions of a meta-analysis hinge on the data of only one or two influential studies, then the robustness of the conclusions is called into question. Outlier and influence diagnostics would be helpful to confirm the validity of conclusions.

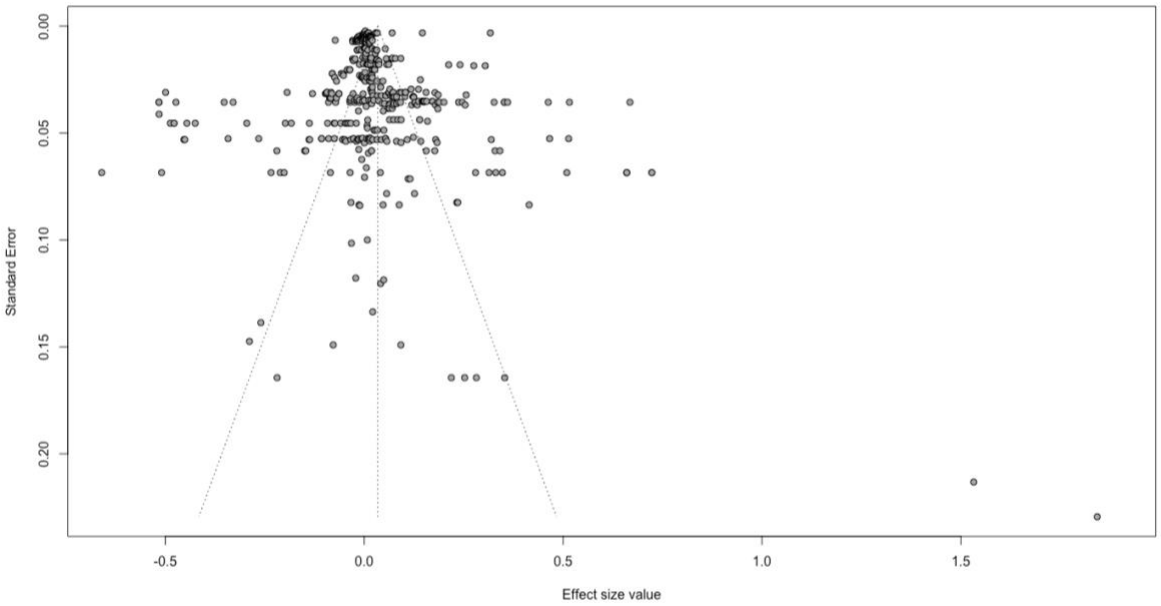

Figure 2.3 Funnel plot of 502 effect sizes against their estimated standard error

2.8.2 Outlier and Influence Diagnostics

First, the outliers were identified based on an examination of the studentized deleted residuals. This measure shows the standard deviation changes of the predicted pooled effect after excluding each observation ES_{ij} from the model fitting. In my review of primary studies, observations with absolute studentized deleted residuals larger than 1.96 called for a closer inspection. [18] It is argued that outlying cases may not be of much consequence if it exerts little influence on the results; rather, if the exclusion of an observation from the analyses leads to considerable changes in the fitted model, then the observation may be considered to be influential (Viechtbauer and Cheung 2010). Case deletion diagnostics, such as Cook's distances, and covariance ratio values were adapted to identify such observations. Cook's distance printed out the distance between the entire set of predicted effect values once with the observation ES_{ij} included and once with ES_{ij} excluded from the model fitting. Covariance ratio was the determinant of the variance-covariance matrix of the parameter estimates when the study was removed divided by the determinant of the variance-covariance matrix of the parameter estimates based on the complete dataset.

[18] As shown in the Figure *2.3*, the effect size observations exhibit a high level of heterogeneity with many observations outside the 95 percent contours. So, it is not surprising to find 257 effect sizes as potential "outliers".

The diagnostics identified 11 effect sizes from 3 studies (Baek 2018; Gamper-Rabindran 2006; Melo and Wolf 2005) as the outlying and influential cases. The covariance ratio values for these observations suggested that precision could be gained by their removal. Repeating meta-regressions after exclusion of these effect sizes yielded similar statistical conclusions, except that educative assistance, though positively related to program efficacy, is no longer significantly associated with program outcomes in sustainability. Table *2.5* shows the outlier-correction results. This demonstrates that, in this context, the presence of potential influential outliers does not call into question the conclusions from the meta-regression results, therefore facilitating the robustness of the findings.

Table 2.5 Outlier-correction results

	Random Variance Estimation			Multilevel Modeling		
	(1)	(2)	(3)	(4)	(5)	(6)
Baseline outcome						
Constant	0.032 ***	0.003	-0.030	0.045 ***	0.008	-0.032
	(0.013)	(0.036)	(0.040)	(0.011)	(0.038)	(0.063)
Program design						
External auditing		0.089 ***	0.125 ***		0.090 ***	0.134 **
		(0.027)	(0.034)		(0.030)	(0.061)
Public disclosure		0.004	-0.007		0.008	0.011
		(0.019)	(0.023)		(0.027)	(0.039)
External auditing × Public disclosure		-0.069 **	-0.101 **		-0.077 **	-0.116 *
		(0.031)	(0.035)		(0.038)	(0.065)
Educative assistance		0.018	0.036		0.018	0.035
		(0.020)	(0.022)		(0.020)	(0.012)
Sponsorship						
Government sponsorship			0.041			0.035
			(0.033)			(0.055)
Industry sponsorship			0.005			0.001
			(0.033)			(0.057)
Cooperative sponsorship			0.040			0.054
			(0.042)			(0.063)
Within-study covariates						
Intermediate outcome		0.004	0.003		0.001	0.001
		(0.017)	(0.018)		(0.015)	(0.015)
Two-stage model		0.048 ***	0.054 ***		0.045 **	0.049 ***
		(0.016)	(0.019)		(0.017)	(0.018)
Control of pollution records		-0.036	-0.045		-0.037 *	-0.048 **
		(0.031)	(0.033)		(0.021)	(0.023)
Control of regulatory pressure		-0.004	0.005		0.004	0.006
		(0.015)	(0.017)		(0.014)	(0.015)
Between-study covariates						
Developing countries		-0.036	-0.043		-0.035	-0.040
		(0.026)	(0.030)		(0.026)	(0.026)
Rescaled time span (in years)		-0.025	-0.017		-0.029	-0.020
		(0.069)	(0.068)		(0.029)	(0.029)
Rescaled median of sample year		0.002	-0.009		0.002	-0.011
		(0.027)	(0.027)		(0.038)	(0.039)
Number of observations	491	491	491	491	491	491
Number of studies	41	41	41	41	41	41

Note: Estimation results with standard errors in parentheses. Significance is indicated by *, ** and *** for the 10, 5 and 1% levels, respectively.

2.9 Conclusion

This study extends established studies on voluntary environmental programs with an institutional design perspective and a meta-analytic context. Scholars and practitioners have expressed concerns about the efficacy of VEPs. Pooled effect size estimates were computed for each of the four different institutional design features: monitoring mechanism, disclosure rules, educative assistance, and program sponsorship. Using a meta-regression approach, I consider these features as the independent variables of interest, which might explain why some VEPs succeed while others fail regarding environmental stewardship.

The analyses provide evidence for the overall utility of VEPs and the moderating effects of some institutional design features. In particular, the unconditional mean effect size reveals modest effects of VEPs on promoting environmental protection. This provides important new evidence of the overall efficacy of VEPs which counteracts the meta-analytic findings conducted more than a decade ago.[19] Moreover, there is strong statistical evidence of a positive relationship between external-audited monitoring mechanism and VEP efficacy when compared with the mechanism of self-regulation. However, an unanticipated result is found for public disclosure rules. Though public disclosure is considered a strong institutional design in the theoretical assumptions, disclosure as a regulatory mechanism does not work nearly well enough as expected. In an external-audited VEP, the existence of public disclosure even decreases the level of program efficacy in all the meta-regression models. In addition, there is a moderate support of educative assistance in related to VEP efficacy. This finding contradicts my hypothesis that educative assistance, as a weak institutional design, not necessarily significantly contributes to the effectiveness of a VEP. Finally, my model results show that differences in program sponsorship cannot explain the efficacy heterogeneity in VEP literature. Though third-party and cooperative sponsorship is more likely to be positively related to VEP efficacy, and industry association sponsorship is negatively associated with the latter, these effects are not statistically significant. These findings indicate further research on program sponsors and their behavioral choices in voluntary programs.

However, these results have to be viewed cautiously due to several reasons. First, it is important to recognize that though VEPs demonstrate a modest effect on improving environmental performance, they may serve a more nuanced role that is not shown in this study. As discussed earlier in this study, the objectives of the VEPs could vary. If a VEP is designed to foster collaborative relationships between government agencies and the regulated community, or between industry associations and their member firms, its impact on sustainable development can be moderate, but it offers important value for promoting shared learning and capacity development. In other words, even though the environmental impacts of VEPs is shown moderate, one cannot negate their potential influence on some unquantified environmental measures, which is not covered in this study.

Moreover, since the study collects data from existing literature on VEPs, there might be some bias towards certain types of VEPs and certain types of results. For example, these programs might be the ones that are better-developed and better-managed so that they are able to

[19] A discussion of the different findings is available in the Appendix where I employed Monte-Carlo simulations to replicate Darnall and Sides' (2008) meta-analysis results.

provide quality data for academic researchers. In this way, the sample programs included in the review does not necessarily represent the VEP population in practice. Based on this, care should be exercised in extrapolating the findings to predict the environmental performance outcomes of other programs with similar or different institutional design features. Besides, publication bias may have caused an overestimation of effect size values in my analysis. I have examined potential publication bias with both visual and statistical tests and they show a downward publication bias with reported effect sizes tending towards negative and significant. For this reason, the magnitude of the relationship between VEPs and environmental improvement might be more likely to be underestimated than to be overestimated on the population level. [20]

Another issue worth mentioning is the heterogeneity of effect size estimates. This is particularly true for within-study heterogeneity. In this review, a majority of primary studies includes more than one effect size estimates. However, due to data availability, it is unlikely to capture within-study but between effect-sizes heterogeneities. For example, one study may report several model results with different measures of firm sizes, such as total assets, sales, number of employees, and also the square form of these. But in my review, these different measures are categorized into one single variable as to whether the model controls for firm size. Given the small number of primary studies in my view, many control variables, though coded in data preparation, are not present in meta-regression. This includes the industry types in the study, product proximity to end consumers, whether controlling for firm size or visibility, and estimation approaches. With more empirical studies added, the heterogeneity issue can be better addressed.

Finally, there is a potential correlated or even causal relationship between sponsorship and institutional design elements. Program features of monitoring regime, disclosure mechanism, and education assistance can be highly correlated with the categories of sponsorship. Studies, such as Prakash and Potoski (2012), Darnall, Ji, and Potoski (2017), have indicated that industry associations are more likely to create programs that are "acceptable" to their members, The correlative relations reduce the variations across the independent variable of interest which might constrain the validity of the analysis.[21] The specific causal relationship between sponsorship and program design, and between sponsorship and program efficacy is to be investigated. Despite the limitations, this research demonstrates the need for future research to look into how VEPs are different regarding their purposes and designs, and how different design features can influence the values of voluntary actions in environmental governance.

With regard to future research, my review of the literature identifies some additional aspects that have not yet been investigated sufficiently. For example, it is still not clear whether and under what conditions public disclosure is an effective design for addressing free-riding problem in collective actions. Compared to external auditing mechanism that provides

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[20] See Appendix for the sensitivity analysis in regards of publication bias concerns.

[21] To check the independence of sponsorship and program designs, I performed a two-stage estimation approach for statistical consideration. I estimated the first stage of the following linear relationship between sponsorship and designs. Using the residual term from the first stage that captured the effect of sponsorship on program outcomes that is independent of the program design variables, I estimated second stage with the multilevel and robust variance estimation models. The results indicated that sponsorship alone was not associated with program efficacy; however, it could impact VEP outcomes through the effect of program designs related to it.

environmental performance information and technical advice directly to firms, public disclosure seems to indirectly impact firm choices through external pressures from customers, investors, regulators, and the community. Concerns surround this process: firms may strategically disclosure information to conceal the negative aspects of their environmental performance; or disclosure information can be difficult to understand for the intended public. It would be interesting to consider the effects of public disclosure rules in future studies in order to shed more light on the role of voluntary measures in environmental governance.

Moreover, additional research on program duration is needed. Moderator variables of median sample year and time span of study are both included in the meta-regression. Generally, these two variables are likely to be negatively associated with VEP efficacy. That is to say, the effect of VEP in environmental stewardship may decrease over time. There might be two explanations. First, as a voluntary program grows, it becomes harder to incentivize or support its participants to improve their environmental performance. Then, this might relate to the continual operations of VEPs, or the free-riding problem of late adopters. On the other hand, however, the duration problem may be due to failure to account for information spillover effects (Lyon and Maxwell 2011). Besides, future studies could pay more attention to the institutional legacy effects and the stability of VEPs. This may help in understanding questions on VEP's long-term institutional effects.

Another interesting aspect would be to focus on the configurations of rules composing the institutional design arrangements. In my review, the underlying assumption is that the configurations of rules are relatively consistent within each design category, and key differences are adequately captured across categories. However, program rules of each category can be highly different. For example, for the category of public disclosure, some VEPs mandates a disclosure of their participants' certification results, but some VEPs only require a written statement with some necessary performance information. Since VEPs are more apt to allow varying stringency levels across programs and across participants, attention to the specific configurations of rules within each design category would be more implicative.

Taken together, the results of the meta-analysis indicate the ability of VEPs to elicit improvements in their participants' environmental stewardship. The effects of some VEP design features, such as external monitoring mechanism and educative assistance, have been confirmed. However, the effects of other designs, such as public disclosure rules, are not supported. This study emphasizes the importance of a clear distinction between different institutional designs in regard to explaining program effectiveness. My review also shows that several aspects have not yet been investigated in sufficient detail in the context of VEPs and might be addressed by future research. These aspects include the role of program sponsorship, influences of different subtypes of public disclosure, potential duration effects of VEPs, and the selection of empirical estimation approaches. All together, these results help better understand the advantage and disadvantages of VEPs as a future tool for environmental preservation and provide implications for the process of designing and implementing environmental policy instruments.

Chapter 3 Private Governance Regimes and Public Regulatory Settings: Domestic Institutions and Their Role in the Global Adoption of LEED Certification

3.1 Introduction

After almost three decades of remarkable development, voluntary environmental programs (VEPs) have become an important policy instrument that fundamentally changes global environmental thinking. Through VEPs, firms commit voluntarily to improve their environmental practices beyond what is required by law. Although they need to bear the costs of producing environmental public goods such as cleaner air, cleaner water, or better landscape, they earn benefits of goodwill by signaling their environmental commitment to external stakeholders who cannot otherwise fully observe the firms' internal practices (Prakash and Potoski 2013). Theoretically, as long as the benefits they gain from the signaling effect outweigh the costs of fulfilling their commitment, firms have incentives to participate in a VEP. Indeed, if their stakeholders hold salient environmental preferences, VEPs offer firms a low-cost approach to distinguish themselves from their peers for their environmental stewardship. Participation in VEPs has grown exponentially: many VEPs have a substantial number of adoptions across the globe, such as LEED for green buildings and ISO14001 for the environmental management system. When trying to go further and understand different patterns of cross-national adoption of VEPs, one wonders what are the factors that influence private actors' decision-making process, and whether or how their cost-benefit calculations are contingent upon respective domestic contexts. Do domestic institutions change firm-level responses to VEPs?

While there has been a great deal of scholarship investigating the adoption of environmental policy instruments, country-level factors are both theoretically and empirically less explored relative to the factors at the firm level. Videras and Alberini (2000) summarized four reasons for firms to join VEP, and basically, these reasons can be divided into two types. The first one is related to the economic or business considerations: firms join VEPs to gain a competitive advantage over competitors or appeal to consumers who demand "green" products and are willing to pay more for them or. For example, Arora and Cason (1995) and Khanna and Damon (1999) found that proximity to final consumers is a significant predictor of participation. While the second one regards regulatory concerns: firms seek regulatory relief from the government or preempt government regulation. For example, Lyon and Maxwell (2011) assumed that a stronger legislative threat is related to a higher level of VEP participation rate. Most studies that examine the determinants of participation in VEPs have tested the economic reason for individual firms. As for the empirical testing of the regulatory reasons, previous studies often focus on one program and use industry type as a proxy to measure the regulatory background of the firms (as in Arora and Cason 1995). In this study, I aggregate firm-level environmental practices to the country in order to extend the VEP literature by linking micro-level corporate practices with macro institutions prescribed in economic development stages and public regulatory policies.

Through this study, I reexamine the income-environment relationship and investigate the institutional configurations that affect the interactions between economic growth and environmental mechanisms. In particular, I introduce the domestic public regulatory institutions

into this discussion. Due to the fact that countries vary in the quality of regulatory governance and the ambition of environmental protection, domestic institutions help explain firms' strategic decisions on participating in a private voluntary program. By adding a moderating effect of domestic regulatory institutions, this study challenges the argument that the role of economic development is the unconditional driver of private regime adoption and informs how regulatory institutions shape actor incentives to join private regimes.

To evaluate these arguments, I define an empirical model that includes interactions between voluntary programs and the institutional environment at both the macro and micro levels. In particular, I examine firm level responses to an international green building standard, Leadership in Energy and Environmental Design (LEED), across nations and offer an institutional explanation for why the responses vary widely. In an effort to incorporate a full set of operative institutions for voluntary environmental regulations, I uncover the economic and regulatory disparities across different countries and link them to the private adoptions of the LEED standards. My findings conclude that the characteristics of both domestic and international institutions need to be taken into account to explain the cross-national variations in firm-level responses. Moreover, by marking the moderating effects of domestic regulatory institutions, it enriches the income-environment debate as to whether economic development is the unconditional driver of private environmental regime adoption. And the empirical analysis provides evidence of strategic decisions private actors made to contribute to environmental improvement.

3.2 Leadership in Energy and Environmental Design (LEED)

Buildings have significant environmental and health impacts. The impacts occur not only during the construction or renovation of buildings but also during their day-to-day operation. According to the U.S. Energy Information Administration (EIA), residential and commercial buildings account for 40 percent of the country's total energy consumption, 70 percent of the total electricity consumed, and over one-third of energy-related emissions that is more than any other sector of the economy. As an attempt to reduce buildings' negative environmental impacts throughout their life cycle, the U.S. Green Building Council (USGBC) was established in 1993 to carry over the concept of "green building". USGBC is a nonprofit organization that builds up its team with representatives from the construction industry, government agencies, other nongovernment organizations, and citizen groups. In 1998, the USGBC launched the LEED Green Building Rating System to establish a common standard of measurement to define green buildings. Under the LEED rating system, builders or owners first register their buildings to seek LEED certification. A third-party certifier, the Green Business Certification Inc. (GBCI), will then assess the buildings across five key areas (i.e., sustainable site development, water savings, energy efficiency, materials selection, and indoor environmental quality) and give credits for meeting respective requirements. The registered buildings "must document how they have met each of the credits they are seeking. There are a few mandatory credits, such as reducing energy usage by 10 percent over a standard building, but the rest are up to the building owner to select" (Cidell and Cope 2014, 1766). Depending on the number of points received, the building can obtain a Certified, Silver, Gold, or Platinum certification for its environmental practices. Since its inception, the LEED standard has played a major role in promoting environmental practices in

building design and construction. The growth of LEED registered buildings has been increased exponentially. After 2008, the sustained growth rates of LEED certified buildings outside the US become salient. According to USGBC's recent report (2021), despite the challenge of the COVID-19 pandemic, 4740 commercial projects and 24,000 residential units received LEED certifications across the world in 2020.

The LEED rating system is a typical VEP in terms of its structure. First, participation is voluntary. To have a building certified, its builder or property owner must ensure that the building meets some of the certification criteria. Though the criteria show striking similarities to those in traditional, statutory construction regulation, the certification process is administered by USGBC with no formal ties with governments (van der Heijden 2015). There are not any penalties from the government for not meeting any LEED criteria. Second, LEED provides excludable market opportunities for its certified buildings. As the most widely adopted private voluntary program for green building standards in the globe, LEED provides its certified buildings with a clearly visible and internationally recognized branding signal of environmental stewardship. In the construction sector, the certification of LEED evidences a building's leadership in environmental sustainability, which means it is assessed as the best in its class. The idea underlying this certification tool is that by ranking a building in a certain class with graded points, its environmental performance (such as energy, water, and material use) can easily be compared to that of other buildings of the same class (van der Heijden 2015; van der Heijden and de Jong 2013). For stakeholders like property developers, investors, owners, and occupants alike, it is easy to understand that a platinum-class building is much better than a certified-class building. Such building assessment performs excellent marketing and branding. Empirical research has shown that office space with sustainable features could bring the property owners higher rents or selling prices (Eichholtz, Kok, and Quigley 2010). As a result, LEED has disseminated to 135 countries and territories, and have approximately 126,000 building projects certified (USGBC, 2020). However, it has not yet been addressed often in literature. Because the salience of green building practice as reflected in LEED adoption varies across countries, even within the respective developed or developing world, I investigate its drivers.

3.3 Factors that Explain LEED Adoption Decisions

As VEPs proliferate across sectors and countries, the literature on their adoption has as well grown rapidly. Several mechanisms that support cross-national VEP adoptions have been identified to shed light on the questions of why property builders or owners adopt the voluntary LEED standards. In particular, Corbett and Muthulingam (2007) argue that LEED adoption is driven by intrinsic and signaling benefits. Similarly, Matisoff et al. (2014) recognize performance based and marketing based benefits as two types of motivations for green building adoption.

In the first case, buildings seek LEED certifications because they expect actual environmental and economic benefits to be a direct result of LEED membership, regardless of the external conditions. VEPs like the LEED program bring together businesses or individuals with common concerns and provide technical guidelines to promote sustainability. During this process, participants get the chance of learning and sharing the most advanced experience. VEPs

act in such an informed manner to increase the capacity of their participants while minimizing harmful environmental impact. In recent years, many buildings seek sustainability certifications to improve their buildings' environmental performance. An extensive literature reports the benefits of buildings going green, including lower operating costs, lower incremental construction costs, improved indoor air quality, and productivity gains (Cidell and Beata 2009; Cole 2010; Corbett and Muthulingam 2007; Fisk 2000; D. C. Matisoff, Noonan, and Mazzolini 2014; Srinivas 2009).

With regard to the external mechanism, buildings wish to communicate their environmental practices to the outside world, including their prospective customers, employees, investors, governments, and the broader public. The VEP literature suggests that businesses join VEPs mainly because they are able to credibly signal their commitment to environmental stewardship through their program membership. Many VEPs operate certification or benchmarking schemes, which confer benefits on recognized firms or products that allows external stakeholders to differentiate environmental leaders from laggards (Chrun, Dolšak, and Prakash 2016; Sandoval and Prakash 2016). Green building certification schemes, such as LEED, serve to provide stakeholders with a basis for comparison among available alternatives (Crawley and Aho 1999; D. C. Matisoff, Noonan, and Mazzolini 2014). Suppose a property company plans to upgrade its existing property to be a green building. If the renters or buyers are uninformed or cannot verify the improvement, the company might struggle to lease or sell this better-performing building to recoup the investments. However, if the company gets this upgraded building LEED certified, it will acquire the ability to signal renters or buyers about the quality or energy efficiency of the building. Overall, this external motivation mechanism lies in LEED's external signaling value, independently from the internal performance benefits from the certification.

However, due to the complex nature of the corporate decision-making process, these two categories developed by existing literature are not sufficient to explain individual differences in the adoption of green building certification. First, either the internal or the external mechanism only considers a set of indicators of program benefits, but the costs of adoption are neglected. The literature on sustainable practices indicates that one key driver of environmental investments is that they can frequently lead to unexpected but significant operational improvements (Corbett and Klassen 2006; A. King and Lenox 2002). However, scholars argue that improving environmental practices is associated with financial gains usually in the long run (Rassier and Earnhart 2011). Horvathova (2012) even finds that environmental performance is associated with additional costs to firms in the short term. This means a rational firm would upgrade its production units only when it accumulates enough financial capital and has the capacity to bear the financial loss, at least in the short term. Thus, the pursuit of environmental performance is necessarily related to the economic or financial capacity a firm holds. In fact, the benefits of seeking environmental practices, such as adopting LEED, would not reveal significance if economic costs and financial capacity are not taken into account.

3.3.1. Income Level

Scholarship has indicated that reliable funding is a prerequisite for environmental practices. To aggregate individual firms into the national level, one would wonder whether the relationship between income and environmental practices would work in the same manner. Since the early

1990s, there has been an enduring discussion on the environment-income relationship. As the earliest and the most significant argument regarding this relationship, Environmental Kuznets Curve (EKC) argues that there is a U-shaped relationship between environmental quality and economic growth: as a country's wealth accumulates, environmental quality initially worsens, but after a certain wealth level, environmental quality starts to improve (Grossman and Krueger 1991, 1995; Shafik 1994). That is to say, countries at the very early stage of their development may suffer from environmental deterioration due to higher levels of economic activities and the use of inefficient resources. However, as the income rises, they may be able to afford a higher level of environmental quality since resources become available for environmental protection and pollution cleanup (Arvin and Lew 2011). With this in mind, the improvement of environmental practices will not likely happen until the country's wealth achieves a certain level (beyond the critical point in the U-shaped curve). However, beyond this level, environmental quality becomes a normal good with a positive relationship between income and the demand for it. In other words, a rise in real income leads to a rise in the demand for environmental quality. As a result, people with higher incomes tend to have a higher willingness to pay (WTP) for a clean and healthy environment. Builders or property owners of the wealthy nations tend to have a higher WTP for investment in environmental practices, like energy saving techniques or eco-friendly designs. They place more environmental quality goods than poorer nations and would probably choose to join a green building certification scheme, such as LEED, in pursuit of advancing their environmental performance. From the supply side, empirical investigations have found a positive relationship between economic development and firm scale (Poschke 2018; Tybout 2000). Since larger firms typically are more established and have greater access to funding, they are more capable and more likely to adopt environmental practices, compared with smaller ones. Thus, wealthy societies have more resources available to reduce their environmental impact, and I hypothesis that national income is positively associated with environmental actions. In the LEED case, I hypothesize that

> **Hypothesis 1**: LEED adoption rates are generally higher in countries with higher income per capita.

3.3.2. Regulatory Institutions

Second, despite the volume of work highlighting the external signaling effect of certification schemes, there is little discussion on the conditions under which signaling effect may create incentives for buildings to ratchet up their environmental practices in a certification scheme like LEED. One possible factor to explain the heterogeneous reactions to the signaling effect is the robustness of public laws (government environmental regulations). However, there is no consensus on its impact. Scholars of policy sciences and governance typically contend that firms join a VEP to preempt the implementation of government regulation that is stricter than that of the VEP or ease their compliance with government regulation (van der Heijden 2015; Jordan, Wurzel, and Zito 2005; Short and Toffel 2010). However, when their principal concern is not the threat of regulation but the development of business partnership and customer base instead, this argument may lead to a false conclusion. In fact, Prakash and Potoski (2014) empirically show that less stringent environmental regulations pressure ISO14001 participants to become more sustainable. Even so, the linkages between public regulatory institutions and the VEP adoption itself are not yet validated.

Countries vary widely in the design and stringency of regulatory governance, and this impacts firms' strategic decisions on participating in a private voluntary program (Chrun, Dolšak, and Prakash 2016). Domestic *public regulatory institutions* structures firms' costs and benefits regarding their investment in environmental stewardship beyond the countries' legal requirements. However, there are mixed arguments about the effects of regulation on the VEP decision. As mentioned above, a higher regulatory threat seems to be more likely to relate to a higher level of VEP participation rate. However, according to Prakash and Potoski (2014), firms have reasons from both the benefit and the cost perspectives not to seek LEED adoptions in a stringent public regulatory setting. From the cost side, in compliance with relatively stringent regulations, firms need to invest more substantial resources. This reduces the levels of "slack" resources (Cyert and March 1963) available for the firms to take other, beyond-compliance stewardship activities. From the benefit side, when public laws set a high regulatory bar, the marginal benefits firms can harvest from joining a private voluntary program is likely to be lower. Since the public regulation has already forced both the VEP participants and nonparticipants to exhibit a high level of environmental stewardship, it becomes difficult for the firms to distinguish themselves through a VEP signal. Under this situation, firms are less incentivized to differentiate themselves through voluntary program participation.

From the perspective of external signaling mechanisms, for-profit firms are motivated to find a way to signal their good behaviors to their stakeholders. Different from the mechanism of internal performance benefits, the signaling mechanism emphasizes the communication of firms' environmental practices towards their external stakeholders, including governments, customers, and the broader public. In a country with a poorly designed and loose environmental regulatory scheme, compliance with formal regulations is not able to convey a strong signal of environmental stewardship. Under such a circumstance, firms are more likely to resort to a well-established private program. The private voluntary regimes serve as a substitute for public regulation. Firms, by joining a trustworthy private regime, may get rid of the undesirable reputation of public laws and send a strong signal of environmental stewardship to their market consumers and financial stakeholders. Besides, membership of such a private regime can also signal the regulatory bureaucrats of their beyond-compliance commitment so that they would be the low priority for regulatory inspection and would preempt any regulation that could potentially incur an enormous cost to them. When the environmental regulation is lax, regulators usually do not have much knowledge of each firm's enforcement status, firms are more likely to earn regulatory relief by sending credible signals to those regulators. Therefore, LEED, as an internationally recognized building standard with a strong signal of environmental stewardship, are more likely to be adopted by firms in countries with lax environmental regulation. Accordingly, public regulatory institutions tend to be positively related to individual decisions of adopting LEED. Thus, I propose that

> **Hypothesis 2**: LEED adoption rates are higher in countries with relatively weaker environmental policies, everything else equal.

3.3.3 Interaction Between Income Level and Regulatory Institutions

In addition, given the fact that the economy and environment are inextricably linked, one would also wonder about the nexus between economic variables and governance indicators. Despite knowledge of these two factors separately, the relationship between them remains unresolved.

For example, it is unclear whether the relationship between public laws and LEED adoption is consistent across different levels of economic conditions; similarly, the question remains whether the relationship between economic variables and LEED practices shows different patterns when the public laws are taken into consideration.

Specifically, while it is plausible to assume that increases in wealth lead to increases in discretionary spending on green development and therefore participation in VEPs, irregularities generated by country-specific conditions are often observed (Dasgupta et al. 2002; Dinda 2004; Stern 2004). Table *3.1* shows the 20 countries or regions that have the most LEED certifications around the world in 2018. Most of them are developed countries or regions with GDP per capita larger than $20,000. However, there are some developing countries with extremely low incomes that exhibit strong ambitions in green buildings, such as India and Bangladesh. This brings to the forefront questions concerning why LEED performs differently in these countries and which factor dominates this difference. Why does LEED show superior performance in some developing countries compared to many other developed countries? Do governance variables change the relationship between economic development indicators and environmental scheme performance? The interactions between economic and governance factors would help decide the external validity of VEP studies by identifying the limitations of when the relationship between factors holds.

Table 3.1 Top 20 countries and regions for LEED projects in 2018

Rank	Country	Number of Certifications	GDP per capita in US dollar (2018)
1	United States	117,546	62,794.6
2	China	4,635	9,770.8
3	Canada	2,628	46,233.0
4	India	2,077	2,010.0
5	United Arab Emirates	1,990	4,3005.0
6	Brazil	1,456	8,920.8
7	Saudi Arabia	1,274	23,339.0
8	Mexico	1,165	9,673.4
9	Turkey	1,033	9,370.2
10	Germany	831	47,603.0
11	Spain	776	30,370.9
12	Italy	672	34,483.2
13	Bangladesh	657	1,698.3
14	Chile	474	15,923.4
15	Sweden	454	54,608.4
16	South Korea	422	31,362.8
17	Colombia	396	6,667.8
18	Poland	393	15,420.9
19	Hong Kong SAR China	383	48,675.6
20	Finland	370	50,152.3

All else equal, and as argued above, as a country's income increases, firms in this country have a higher level of "organizational slack" to invest in beyond-compliance stewardship practices, and consumers have a higher WTP for environmental products, leading to greater

participation in private environmental programs. However, when the quality of domestic regulatory governance is high, firms are less incentivized to differentiate themselves through VEP participation because there are fewer marginal benefits they can harvest from program participation. As a result, the effect of income in increasing firms' adoption of private regimes is weakened. In contrast, poor quality of domestic regulation provides the opportunities for these actors to differentiate themselves from non-participants for marketing. With increasing "organization slack", the effect of income increases on firm adoption of private regimes is strengthened. As long as firms recognize the voluntary program as a signal of environmental quality, firms will have incentives to consider program participation, especially if they are located in countries with reputations for poor environmental policies. In summary, certification adoption can be conditioned by the status of government environmental regulations. Specifically,

> **Hypothesis 3**: Conditional on the level of income per capita, the higher the level of environmental policies, the lower the effects of income per capita on LEED adoptions.

3.4 Data and Methods

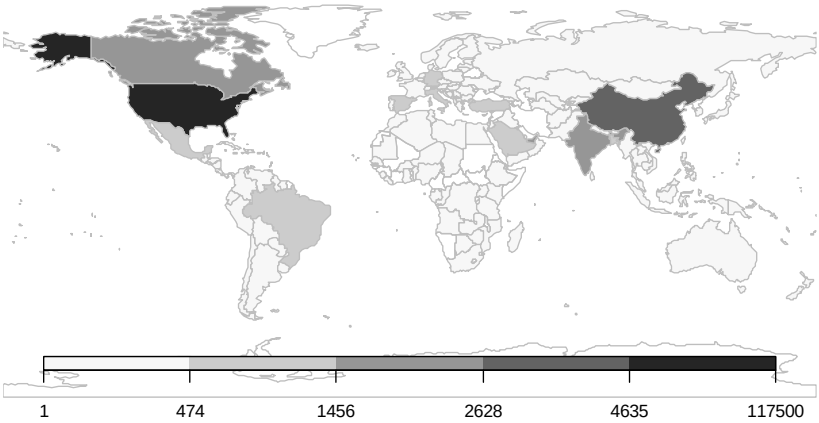
3.4.1 LEED Adoptions

To test my hypotheses, I examine a panel of 146 countries from 2007 to 2018. This research investigates factors influencing the number of LEED certifications within a country. The dependent variable is the number of LEED-certified projects in each country for each year. I include all LEED projects through the time period in the publicly available database from the USGBC, which is a directory of 133,528 certified projects. Data are available on the certification date, certification level and size, location, and the LEED scores on multiple dimensions (sustainability sites, water efficiency, energy and atmosphere, material and resources, indoor environmental quality, innovation, regional priority credits). Figure *3.1* presents a "heat map" for the total number of adoptions across the globe, circa 2019. In this map, darker areas represent larger numbers of total adoptions and lighter areas fewer. As indicated by the dark shades, the group with the greatest number of LEED adoptions is not constrained to developing or developed countries only. The US, China, Canada, India, Brazil, Turkey, Germany, and Mexico are the ones with the most LEED adoptions which respectively exceed 300. While the light shades indicated that some countries only have a few adoptions, like Niger, Zambia, Iraq, Norway, and Venezuela. Additionally, I included the count of LEED projects at different income levels in each country for each year as another set of dependent variables for robustness tests. Moreover, since LEED and BREEAM (Building Research Establishment Environmental Assessment Method) are often considered the two best-known VEPs for the built environment, I collect BREEAM's online adoption data with a web scraping approach. [22] For robustness check, I test my hypotheses using the total count of LEED and BREEAM projects in each country and each year as another dependent variable.

[22] Web Scraper Chrome extension is utilized in this study.

3.4.2 Independent Variables

The primary explanatory variables are income level and the quality of domestic regulatory governance. Data on income level is measured with *GDP per capita* from the Penn World Table. It is adjusted for purchasing power parity (PPP). [23] The natural log of GDP per capita was taken to make the distribution more similar to the dependent variables.



Note: darker areas indicate a greater number of adoptions, data Source: USGBC

Figure 3.1 Global adoptions of LEED till 2020

For the measures of countries' environmental governance, there are usually no perfect proxies with sufficiently broad and long coverage. I use a dataset compiled by the World Economic Forum (WEF) that contains results of annual surveys administered to more than 14,000 business leaders worldwide. In this dataset, two survey questions are relevant to this study with information about the strictness of environmental laws and enforcement at the country-year level.[24] This information is extracted from WEF's Travel & Tourism Competitiveness Reports, publicly available on a biannual basis for more than 150 countries. WEF ranks each country's quality of environmental regulation based on their surveys of top local business leaders on a scale from 1 to 7: (1) the stringency of its environmental regulation (SER) and (2) how strictly these laws are enforced (EER). This measure has recently been adopted by Ben-David et al. (2021), and the validity of the measures is assumed strong "because the WEF measure reflects scores as perceived by corporate leaders, who eventually respond to

[23] For GDP adjustment, PPP is preferred in this research to market exchange rate. One important drawback of the market-based rates is that they are relevant only for internationally traded goods, and they cannot take into account the differences in the prices of nontraded goods across countries. Specifically, this will underestimate the purchasing power of consumers in emerging markets and developing countries (Callen 2007). In contrast, PPP is generally regarded as a better measure of the overall well-being of country residents, which matches my research needs of country wealth measure.

[24] The two survey questions relevant in WEF's *Executive Opinion Survey* are: (1) How would you assess the stringency of your country's environmental regulations? and (2) How would you assess the enforcement of environmental regulations in your country? Answers range from 1 (very lax) to 7 (among the world's most rigorous).

this perception by determining … (the adoption of green certifications) (2021, 8). Since the two environmental policy measures are highly correlated (correlation coefficient of 0.97), I followed Ben-David et al. (2021)'s method to combine the two scores into a single variable to avoid severe multicollinearity issues:

$$ENV = SER \times EER/7$$

So, the combined index ENV measures the overall quality of environmental policies (*Environmental regulation score*) and its value ranges from 0.3 to 6.03. I also examine the effect of each score variable (*Stringency score* and *Enforcement score*) in isolation in the robustness tests. Overall, the results largely remain robust across the three measures.

3.4.3 Control Variables

I include additional control variables to assess alternative explanations articulated by VEP literature and diffusion theory. I include controls for domestic and international factors that can be expected to influence buildings' LEED adoption decision.

Beginning with domestic factors, social and political factors in a country can influence buildings' environmental decisions. The model controls for population size (logged), which I measure with the variable *Population*. Since green buildings are more likely to exist in urban areas, I include the variable *Urban population*, which measures the share of the total population living in urban areas. To measure the capacity of governments to fulfill their social and economic objectives, I use a proxy – *Government consumption* - based on the percentage of government spending of GDP, as reported by World Bank Indicators. I also include a control of the share of household consumption of GDP (*Household consumption*) to measure a country's economic strength and as a proxy for the residents' WTP. Moreover, since green buildings are closely related to the exploration of natural resources and choice of energy sources, I also include a set of environment resource factors from the World Bank Indicators. First, the total natural resource rents (*Resource rent*) are the total revenue that is generated from the extraction of natural resources (such as oil, natural gas, coal, minerals, and forest) less the cost of extracting these resources. This is a measure of the country's economic dependence on natural resources. Since green buildings are dedicated to limiting direct use of natural resources, as the dependence increases, green buildings become less likely to exist in such countries. Second, renewable electricity output (*Renewable output*) is the share of electricity generated by renewable power plants in total electricity generated by all types of plants. I use it to control the country's potential in building going green. Third, I control for total renewable energy consumption (*Renewable consumption*), which is the share of renewable energy in total final energy consumption. This is a measure of the country's acceptance and penetration of renewable energy, which may impact the adoption of green building practices. The energy intensity level of primary energy (*Energy intensity*) is the last environmental measure I include to control for the efficiency of using primary energy to produce economic output. It is the ratio between energy supply and GDP measured at 2011 PPP. This is a rough proxy for energy efficiency, which controls the country's potential of green building development. All the domestic controls are from the World Bank Indicators and are taken natural log for transformation.

According to the policy diffusion theory, international factors can significantly influence domestic environmental practices. I include several controls for these influences. First, I consider foreign direct investment (logged) which is measured by the World Bank with the natural log of net inflows of investment from foreign investors divided by GDP (*FDI inflows*). It is shown in diffusion literature that FDI flows may create coercive and normative pressure on firms to take some environmental-friendly measures, such as adopting energy-saving techniques or participating in a VEP (Baldwin, Carley, and Nicholson-Crotty 2019; Berliner and Prakash 2013). Hence, FDI inflows are likely to be positively associated with LEED adoptions. Furthermore, I collect country-pair proxies such as geographical distance, common border, common language, and annual trade statistics from Andrew Rose's website (see Glick and Rose, 2016). Some country-pair controls are then processed with these proxies. First, I further control for the country's trade openness in terms of the average number of LEED adoptions per capita in a given country's top 5 trade partners (*Trade partners*). In addition, I control for two other international diffusion effects, language context and neighborhood context, since ideas, norms, and practices may flow more readily via shared cultural ties or between contiguous states. The language context variable measures the average number of LEED adoptions per capita among countries sharing a common language (*Common language*) because the costs of transmitting ideas and norms (such as in LEED) are likely to be low when actors are in the same linguistic network. Neighborhood context measures the average number of LEED adoptions per capita in countries that share contiguous borders (*Common border*), and in the given country's top 5 closest countries (*Closest neighbors*). Information and norms flow more readily between contiguous entities or neighbors simply because neighbors are likely to have more opportunities to exchange information and to observe one another. These controls are processed using the Glick and Rose country-pair dataset and the LEED directory.

As expected, the data were not complete for all variables for all countries in my sample. The lowest level of completeness came from *Energy intensity*, *Renewable output*, and *Renewable consumption.* They were about 75 percent complete. Other variables were at least 90 percent complete. Instead of list-wise deletion via dropping countries with missing data, I imputed the missing data with linear interpolation and extrapolation approaches. To ensure the validity of my results, I also tested the same models with list-wide deletion imputation and the results are shown in the section of sensitivity analysis. Table *3.2* presents the descriptive statistics of the dependent and explanatory variables in the imputed dataset. To allow the explanatory variables to predict what will happen in the outcome variable, all explanatory variables are lagged by one year. Temporal lags of spatially lagged variables help mitigate the temporal dependence of LEED certifications. The sample for the empirical test finally contains 146 countries across 11 years.

Table 3.2 Descriptive statistics

Variable	Mean	Standard Deviation	Minimum	Maximum
Adoptions of green building programs:				
LEED (#)	76.22	830.36	0	19481
BREEAM (#)	8.3	94.74	0	1908
LEED + BREEAM (#)	84.52	835.28	0	19481
Income variable:				
GDP per capita (US $)	21168.4	22268.36	378.1	166520.5
Environmental regulation quality measures:				
Stringency score (from 1 to 7)	4.06	1.04	1.5	6.6
Enforcement score (from 1 to 7)	3.86	1.05	1.4	6.4
Overall score (from 1 to 7)	2.39	1.25	0.3	6.03
Domestic Controls				
Population (in millions)	46.88	158.86	0.09	1427.65
urban population (% of total population)	59.67	22.38	9.864	100
government consumption (% of GDP)	17.85	6.58	2.04	59.15
household consumption (% of GDP)	62.59	16.2	8.55	118.92
natural resources rent (% of GDP)	6.78	9.66	0	58.98
renewable electricity output (% of total electricity)	35.95	3.34	0	100
renewable consumption (% of total final energy consumption)	33.38	29.23	0	97.17
Energy intensity level	5.84	3.95	0.19	28.5
International Controls				
# of adoptions in countries that share a common border	196.62	1172.94	0	19492
# of adoptions in countries that share a common language	3058	5063.7	0	21669
# of adoptions of country's top 5 closest countries	205.5	1441.85	0	19753
# of adoptions of country’s top 5 trade partners	3807.8	5367.82	0	21649
FDI net inflows (% of GDP)	6.202	18.95	-58.32	449.08

3.4.5 Model Specification

To estimate the count of LEED adoptions certificated in each country for each year, I use a fixed-effects negative binomial specification, where the fixed effects are defined at the year and country level. This model specification is chosen based on the structure of the dataset. As shown in Figure 3, like many count variables, the count of LEED certifications is discrete, contains only non-negative integer values, and follows a highly skewed distribution. More specifically, it has a mean of 76.22 and a standard deviation of 830.36. Pertaining to the data features, standard linear regression techniques cannot be applicable. An alternative is to use a Poisson model. Its advantages over the linear regression model are 1) it assumes that the residual errors follow a

Poisson, not a normal distribution; 2) rather than modeling the response variable as a linear function of the regression coefficients, it models the natural log of the response variable, which meets the restriction of predicted values to non-negative numbers (Hilbe 2011). However, the variance of LEED counts is much greater than the mean (i.e., overdispersion), which violates the assumption of the Poisson model. To account for over-dispersed counts, the negative binomial model is often employed by estimating a dispersion parameter α (Cameron and Trivedi 1986). Then the mean and variance in terms of the mean are given as follows:[25]

$$E(y) = \mu, \qquad var(y) = \mu + \alpha \times \mu$$

This equation allows the variance to be greater than the mean. The second term in the variance of y determines the amount of overdispersion. If α is 0, the variance of y is μ. In such cases, the negative binomial converges to the Poisson distribution. In contrast, the larger the α value, the larger the overdispersion. Besides, since the dataset is longitudinal coming in the form of panels, observations within each panel cannot be considered independent. Fixed-effects models are adopted to accommodate extra correlation in the data (Hilbe 2011). Country fixed effects alongside the substantive predictors contribute to the capture of any time-invariant and unit-level forms of cross-section heterogeneity; year fixed effects help address temporal autocorrelation and time-variant unobservable factors. The fixed effects negative binomial modeling technique employed is given as follows:

$$E(y_{it}) = \mu_{it}, \qquad var(y)_{it} = \mu_{it}(1 + 1/\lambda_i)$$

$$ln(\mu_{it}) = \beta(income_{i,t-1} + regulation_{i,t-1} + income_{i,t-1} * regulation_{i,t-1} + x_{i,t-1}) + u_i + w_{it}$$

where μ_{it} is the marginal expectation of the response variable y, and x'_{it} are the covariates of the number of LEED certification (y) for each country i over each year t. x'_{it} contains both the control variables. Apart from variables of GDP per capita and environmental regulation measure, I also include an interaction term between these two variables. The third hypothesis is tested by the sign and statistical significance of this interaction term. u_i and w_{it} represent the country and year fixed effects, respectively. All covariates are lagged by 1 year to account for response time in variables' effects. The overdispersion parameter λ_i represent the canonical structure for negative binomial event count models and adjusts to accommodate data overdispersion. To deal with potential heteroskedasticity across countries and years and potential bias introduced by the imputation of missing data, I employed bootstrapped standard errors. The negative binomial model results will be presented in the following section. As a comparison, the results of the base Poisson model will also be shown with only the core explanatory variables included.

[25] Boswell and Patil (1970) identified 13 separate types of derivations for the negative binomial distribution. Other statisticians argued that there are even more derivations. Most of the time it makes little difference how the distribution is derived (Hilbe 2011). After comparing the goodness-of-fit statistics, NB1 specification is preferred in this research where the exponent of μ is 1.

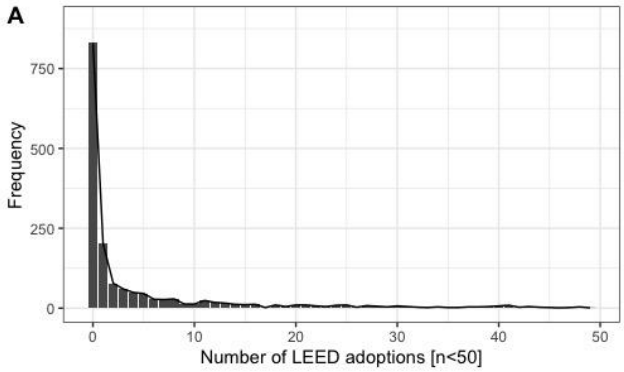


Figure 3.2 Distribution of LEED certification counts (n<50)

3.5 Results

Table *3.3* shows the count regression model results of the factors influencing LEED certification adoptions in 146 countries for the years 2007-2018. Model (1) and (2) are both based on the Poisson model and only consider the main independent variables. The only difference between the two models is that country and year fixed effects are added to Model (2). Model (3) considers the same variables but shows the results of fixed effects negative binomial regression, and Model (4) adds the remaining control variables, based on Model (3). As can be seen, Model (1) has an exceedingly high dispersion value of 2852.297. This validates my concerns about the data structure. First, the panel data structure seems to violate the distributional assumption of likelihood independence; and second, there is an excess variation in the LEED counts. Overdispersion may cause standard errors of the estimates to be underestimated lead one to falsely reject the null hypothesis. To ameliorate Poisson overdispersion, I first add fixed effects to Model (2), and as shown in Table *3.3*, the dispersion statistic is greatly reduced to 15.526. With negative binomial distribution employed, the dispersion values in Model (3) and (4) exhibit additional declines and reach some level slightly above 1, which indicates an effective correction of overdispersion. [26]

[26] According to Hilbe (2011), small amounts of overdispersion are of little concern. If the dispersion statistic is greater than 1.25 for moderately sized models, then a correction may be warranted.

Table 3.3 Determinants of LEED adoptions at country-level

Variable	Poisson		Negative binomial	
	(1)	(2)	(3)	(4)
IV: Income variable:				
GDP per capita	2.148***	3.954***	2.597***	2.606***
	(0.013)	(0.068)	(0.168)	(0.562)
IV: Environmental regulation quality measures:				
Environmental regulation score	2.659***	5.028***	4.437***	3.525***
	(0.042)	(0.196)	(0.575)	(1.196)
IV: Interaction between income and regulation:				
GDP per capita × Environmental regulation score	-0.234***	-0.497***	-0.459***	-0.371***
	(0.004)	(0.018)	(0.054)	(0.126)
International Controls				
Common border				0.312*
				(0.169)
Closest neighbors				0.162
				(0.153)
Common language				-0.003
				(0.068)
Trade partners				0.05
				(0.090)
FDI inflows				0.138
				(0.093)
Domestic Controls				
Population				0.799***
				(0.073)
Urban population				0.001
				(0.007)
Government consumption				-0.026
				(0.019)
Household consumption				0.007
				(0.017)
Resources rent				-0.019
				(0.025)
Renewable output				-0.001
				(0.003)
Renewable consumption				0.015**
				(0.007)
Energy intensity				0.065*
				(0.038)
Constant	-18.25***	-37.59***	-23.239***	-26.381***
	(0.138)	(0.733)	(1.672)	(6.182)
Obs.	1606	1606	1606	1606
Year fixed effects	No	Yes	Yes	Yes
Country fixed effects	No	Yes	Yes	Yes
Bootstrapped standard errors	No	No	No	Yes
Dispersion parameter	2852.297	15.526	1.086	1.246
χ^2	1569379.63	24841.38	1735.85	2007.71

Note: Obs. = number of observations; * p < 0.10, ** p < 0.05, *** p < 0.01

As shown in Model (3) and Model (4), there is a significant conditional relationship between the effects of *GDP per capita* and *Environmental regulation score* on LEED adoption levels. That is to say, the effect of income on LEED adoptions depends on the stringency of environmental policies, and similarly, the effect of environmental policies is influenced by the level of income. On average, since the interaction effect is relatively small. It would not change the direction of the two major variables' impact. Therefore, the effect of GDP per capita on LEED adoption is significantly positive, which confirms my Hypothesis 1. However, the effect of environmental regulation is also positive, which seems to be the opposite of my Hypothesis 2 and 3.

To look further at the interaction effect, Figure *3.3* depicts the interaction relationship between the two major independent variables *GDP per capita* and *Environmental regulation score*. In Figure *3.3* depicted on the left, no matter what level of the environmental regulation score, income is positively related to the number of LEED adoptions. Besides, the lower the level of the regulation score, the larger the effects of GDP on LEED adoptions. In Figure *3.3* on the left, I divided sampled countries into four income categories according to the thresholds by World Bank. The figure shows that, in low-income countries, a little increase in environmental regulation score can bring a much larger effect on LEED adoptions. This effect goes smaller as income level increases, and it even turns to the negative when it comes to the high-income countries. So, on average, it verifies my hypotheses about income and the interaction effects of income and environmental regulation score. However, the hypothesis of regulation score does not hold except in high-income countries.

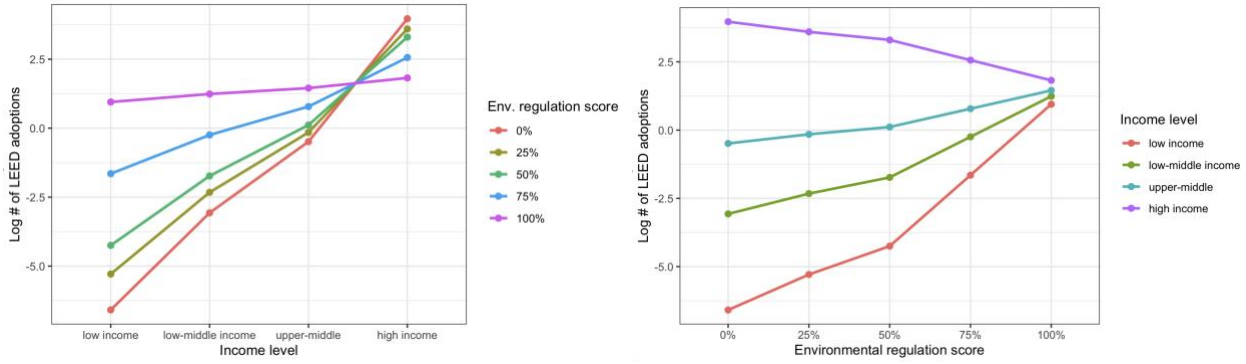


Figure 3.3 Income and environmental regulations as predictors of LEED adoptions

To interpret the level of impacts of these two independent variables, I first take four separate values from the low, lower-middle-, upper-middle-, and high categories for Environmental regulation score. Based on the regression results from Model (4) and holding all other variables constant, I show the effect of GDP per capita in each case in Table *3.4*. According to Table *3.4*, in an economy with very lax environmental policies, for example, if we suppose the measure of Environmental regulation score is 1, one unit increase in the logs of GDP per capita is likely to increase the log of this country's expected LEED adoptions by 2.289 units. This means the number of LEED counts in this country is predicted to increase by 886.5% for

every 1 unit increase in its log of GDP per capita. Yet, suppose a country has the most stringent environmental policies whose Environmental regulation score equals 7, one unit increase in the logs of GDP per capita can only increase the log of this economy's expected LEED adoptions by 0.063 units, and the number of LEED counts in this country would increase by only 6.5% for every 1 unit increase in its log of GDP per capita. The statistics in the table show a declining trend of income effect on LEED adoptions as the environmental regulation score level increases from 1 to 7. This indicates that governance factors can moderate the effect of the economy on environmental behaviors (Hypothesis 3). Since the effect of GDP per capita remains positive across different levels of Environmental regulation score, national income is positively associated with LEED certification adoptions (Hypothesis 1).

Table 3.4 Conditional effect of *GDP per capita* on LEED adoptions

	Environmental regulation score level			
	1	3	5	7
Income effect	2.289	1.547	0.805	0.063

Similarly, to interpret the effects of environmental regulation stringency on LEED adoptions, I take four separate values from the low-, lower-middle-, upper-middle-, and high-income categories for *GDP per capita*.[27] Holding all other variables constant, I extract the coefficient estimates from Model (4) and calculate the effect of *GDP per capita* in each case. The results are shown in Table *3.5*. In particular, in a low-income economy with *GDP per capita* equal $800, one unit increase in *Environmental regulation score* is likely to increase the log of this economy's expected LEED adoptions by 1.045 units, which means a 184.3% increase in the number of LEED projects is likely to happen. Similarly, in an upper-middle-income economy with GDP per capita equal to $10000, one unit increase in *Environmental regulation score* is likely to increase the log of this economy's expected LEED adoptions by 0.108 units, which corresponds to 11.4% increase in LEED certification count. As *GDP per capita* increases from $800 to $10,000, the marginal effect of environmental regulation decreases. However, when the country's *GDP per capita* belongs to the high-income category, such as $50,000, the marginal effect turns from positive to negative, suggesting that the regulation effect is strongly dependent on the level of income. This provides only partial support to Hypothesis 2 that the stringency of environmental policies can negatively impact a country's adoption level of LEED certification; however, this only holds when the country has a high income. For most countries, *Environmental regulation score* significantly increases LEED adoptions, which is in fact not in line with Hypothesis 2. This suggests that, except in a high-income society, a higher stringency of environmental policies can motivate more LEED certifications, which seems to coincide with the argument that firms may join VEPs to preempt strict government regulation (van der Heijden 2015; Jordan, Wurzel, and Zito 2005; Short and Toffel 2010). However, it may also be due to the awareness of green buildings that rises with an upgraded level of environmental policies. Since the regulation effect is statistically largest in low-income countries, the stringency of national level environmental policies can be especially important in such countries.

[27] The income classification thresholds are drawn from World Bank adjusted to 2017 US$. Specifically, low income < $1006; lower-middle: $1006-$3955; upper-middle: $3956-$12235; and high income >$12235.

Table 3.5 Conditional effect of *environmental regulation score* on LEED adoptions

	GDP per capita level			
	$800	$3,000	$10,000	$50,000
Regulation effect	1.045	0.555	0.108	-0.489

Control variables produce results that are generally consistent with prior literature. The results suggest both internal and external diffusion mechanisms in the LEED case. First, the adoption decision of LEED certification is likely to be influenced by the level of adoptions in the neighboring countries that share a common border (*Common border*). However, *Common language* is not statistically significant in Model (4), suggesting that common cultural values do not influence the diffusion of corporate environmental practices that are embodied in LEED certification. This is the same as in Prakash and Potoski (2007b)'s research on ISO14001 diffusion where they provide a possible explanation that since English has become the de facto language of global commerce, language solidarity might not tie countries closely as expected. Regarding the international economy variables, *FDI inflows* and *Trade partners* are neither individually significant. This provides no evidence that FDI or trading networks can serve to transmit norms about the LEED standard. This unexpected result can also be due to the fact that green building related trading and FDI may only take a small share of the country's total statistics. The economy network could be possibly covered by the data limitations. As for domestic variables, Model (4) finds that *Renewable consumption* and *Energy intensity* are both significantly associated with a larger number of LEED adoptions. Since energy efficiency is the most important element of green building, a country's energy capacity should be considered when assessing a country's green building development. In the meantime, it is also worth mentioning that it is *Renewable consumption* rather than *Renewable output* that matters in LEED adoptions, which seems to underscore the effects of social and community norm change on environmental practices. Besides, as expected, population is significantly and positively corrected with LEED adoptions.

3.6 Sensitivity Analysis and Robustness Tests

To assess the robustness of my findings, I also examine some different specifications of the main model. First, it is often argued that LEED together with BREEAM (Building Research Establishment's Environmental Assessment Method) should be the best known VEPs for the built environment. The BREEAM was established in 1990, several years before the inception of LEED, and was introduced by a UK private organization, the Building Research Establishment (BRE). Similar to LEED, it allows the assessment of the environmental performance of buildings and enables them to be ranked against others in their class. But different from LEED that populates in North America, BREEAM dominates the UK market. Since it would be not necessary for a building to get both BREEAM and LEED certified and usually the building would choose one of them, the adoption of BREEAM might impact the decisions of LEED. In the first robustness test, I will add the number of BREEAM adoptions to the dependent variable employed in the fixed effects negative binomial model. Second, as mentioned, the independent

variable of environmental policies is computed from two survey scores produced by WEF. I replace the measure of *Environmental regulation score* with *Environmental stringency score* and *Environmental enforcement score,* separately. Third, since the results presented above are based on the dataset with missing values imputed via linear interpolation and extrapolation, I conduct another test with the unimputed original data as a sensitivity test. All the sensitivity analysis results are shown in Table *3.6*. The findings basically hold across specifications.

3.7 Discussion and Conclusion

Though it is widely argued that the performance and signaling mechanisms together shape buildings' incentives to adopt LEED, the conditions under which these mechanisms work are not clear nor how they complement or undermine LEED certification decisions. As LEED expands steadily across the globe, the exploration of cross-country adoption of this certification scheme becomes even more important. To answer these questions, I examine the variables of economic development and public law institutions, and aggregate firm-level environmental practices to national country. Specifically, this article explores the relationship between income growth and institutional environment to explain the variations persist across countries in pro-environmental behaviors such as the accreditation of LEED.

To begin with, it is expected that firms in countries with higher income would be more likely to get involved in environmental practices (Hypothesis 1). This study tests this argument with the LEED standard, a well-established international standard of green buildings. In particular, my empirical results show that a given country's GDP per capita is positively associated with its expected count of LEED certifications. However, as can be seen in the real world, income alone is not sufficient to explain the heterogeneous performance across countries with the same level of income. For this reason, this study looks at the factors of domestic environmental policies.

As for the effect of public environmental policies on private adoptions of voluntary regimes, there is no consensus. From the cost perspective, if the public law is stringent, then firms need to spend more to fulfill the public standard. On the one hand, there are fewer resources left for the firms to pursue a higher standard beyond the law requirements; but on the other hand, it is also possible that since firms have already reached the stringent standard set up by the government, it would be easier for the firms to achieve the requirements stipulated in the voluntary programs. From the benefit perspective, if the public standard is stringent, on the one hand, firms could signal their environmental stewardship to their stakeholders with their public compliance records. On the contrary, if the public standard is lax, firms may seek credits from another private mechanism to differentiate themselves from their peers. However, from another perspective, if the public standard is stringent, firms may choose a well-reputed private regime to signal their environmental stewardship to the regulators. If the public standard is law, then the firms do not need such a private regime to signal. Above all, from both the cost and benefit perspectives, there can be competing hypotheses. My empirical results about regulation effects in fact show this complexity.

Table 3.6 Results of robustness tests

Variable	LEED+BREEAM	Stringency score	Enforcement score	Unimputed data
	(1)	(2)	(3)	(4)
IV: Income variable:				
GDP per capita	2.285***	3.471***	2.768***	2.364***
	(0.584)	(0.986)	(0.840)	(0.579)
IV: Environmental regulation quality measures:				
Environmental regulation score (or alternative)	3.398*	4.503***	3.318***	1.951**
	(1.363)	(1.613)	(0.575)	(0.964)
IV: Interactions between income and regulation:				
GDP per capita * regulation score	-0.363*	-0.489***	-0.357**	-0.216**
	(0.146)	(0.018)	(0.157)	(0.099)
International Controls				
Common border	0.560***	0.542***	0.551***	0.345*
	(0.200)	(0.168)	(0.168)	(0.230)
Closest neighbors	0.082	0.083	0.113	0.253*
	(0.145)	(0.149)	(0.147)	(0.158)
Common language	-0.131	-0.157**	-0.135**	0.057
	(0.112)	(0.083)	(0.082)	(0.053)
Trade partners	0.120	0.121*	0.097	-0.008
	(0.116)	(0.088)	(0.086)	(0.104)
FDI inflows	-0.031	-0.044	-0.033	0.178
	(0.152)	(0.092)	(0.092)	(0.173)
Domestic Controls				
Population	0.654***	0.664***	0.647***	0.834***
	(0.062)	(0.072)	(0.069)	(0.084)
Urban population	0.012*	0.012**	0.012**	-0.000
	(0.009)	(0.007)	(0.007)	(0.008)
Government consumption	-0.030**	-0.029*	-0.030**	-0.026*
	(0.018)	(0.018)	(0.018)	(0.020)
Household consumption	-0.007	-0.007	-0.007	0.006
	(0.015)	(0.019)	(0.019)	(0.019)
Resources rent	-0.023	-0.025	-0.025	-0.024
	(0.021)	(0.026)	(0.026)	(0.026)
Renewable output	0.004	0.004*	0.004*	-0.001
	(0.005)	(0.003)	(0.003)	(0.006)
Renewable consumption	0.017**	0.018**	0.015**	0.019**
	(0.008)	(0.008)	(0.008)	(0.009)
Energy intensity	0.077**	0.083**	0.079**	-0.047
	(0.046)	(0.043)	(0.043)	(0.038)
Constant	-22.498***	-33.305***	-26.812***	-24.00***
	(6.292)	(10.000)	(8.679)	(6.418)
Obs.	1606	1606	1606	1215
Year fixed effects	No	Yes	Yes	Yes
Country fixed effects	No	Yes	Yes	Yes
bootstrapped standard errors	Yes	Yes	Yes	Yes
Overdispersion value	0.810	0.848	0.777	1.152
	1284.3387	1344.487	1232.07	1376.20

Note: Obs. = number of observations; * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Through the interaction term between income variable and environmental regulation factor, this study finds little, if not none, support for Hypothesis 2, which states that stringency of environmental policies in a given country is negatively associated with the number of LEED adoptions within this country; but strong support for its proposed Hypothesis 3, which indicates that conditional on the level of income per capita, the higher the level of environmental policies, the lower the effects of income per capita on LEED adoptions. These findings contribute to the enduring debate of the income-environment relationship. Though income is found to have a significantly positive effect on environmental practices, this effect is moderated by environmental policies.

The results of environmental regulatory quality are worth more discussion. In my hypothesis, I assume that buildings are likely to signal their environmental stewardship to their clients and investors, so when the regulation is weak, they are more likely to pursue a private regime to differentiate themselves from their competitors. However, the results verified this relationship only in the high-income countries. In less wealthy countries, the effects are the opposite. This seems to meet the arguments of some scholars that firms may join VEPs to preempt public regulations. So, in a country with strong environmental regulation or expect to have a strong environmental regulation, firms are likely to signal to their regulators that they are the good apples and do not need any inspection.

Besides, these findings provide different policy implications to developing and developed countries. The most important implications from this paper might be, in developing countries, since firms are likely to signal to their regulators, it is more efficient to increase the stringency of public regulation. When the income is low, it seems that a small improvement in environmental regulations could lead to a much larger effect on sustainable practices, compared with developed countries. However, in most developed countries, environmental stewardship signals to the clients might be more important. For developed countries with high income (except for upper-middle-income countries), the positive effects of signaling are likely to dominate. While firms in high-income countries are more likely to actively get involved in an alternative private regime if the public regime is lax. The empirical results show that in such countries, the lower the stringency of public environmental regulation, the higher the probability for buildings to acquire LEED certifications. That is to say, when the income is high enough, more public resources could be directed to private regimes such as VEPs and save massive costs spent on public inspection and enforcement. However, this conclusion would merit more theoretical and empirical studies to validate. So probably we can invest less in public regulation, and firms can even choose more sustainable practices with private regimes. Overall, the statistical significance of this environmental regulation indicates potential signaling effects that VEP literature has argued, but to whom is another question that needs further exploration.

Chapter 4 Policy Feedback and Public Mandates of LEED

4.1. Introduction

Concerns over the decreasing amounts of available natural resources have risen dramatically. According to the U.S. Energy Information Administration (EIA), buildings within the country account for 40 percent of energy use, 70 percent of electricity consumption, and over one-third of greenhouse gas emissions (which is more than any other sector of the economy). Since buildings largely depend on heating and energy consumption while occupied, they also contribute to pollution and waste problems related to climate change, acid rain, and harmful health effects on local populations (DeLaPaz 2013). To combat the negative environmental impacts caused by buildings, a green building movement was started by lawmakers, architects, and engineers in the 1970s to seek alternative construction solutions. Following this initial effort, green building initiatives are observed being adopted and implemented by some localities or regions. However, more often, they are likely to be subject to political debates and the prospects for a uniform public sustainable development standard to a level that could greatly reduce adverse environmental impacts of construction practices still seem to deem.

In the face of obstacles to establishing uniform public codes for green buildings, private actors have made endeavors to set up their own standards to promote sustainable construction design. For example, in 1998, the U.S. Green Building Council (USGBC) launched the Leadership in Energy and Environmental Design (LEED) green building rating system to create a common standard of measurement to define green buildings. Under the LEED standard, buildings are registered by builders or owners who intend to seek green building certifications. These registered buildings are assessed across five key areas (i.e., sustainable site development, water savings, energy efficiency, materials selection, and indoor environmental quality) and given credits for meeting respective requirements. Many state and local governments in the U.S. have formally adopted LEED-based policies to promote green building practices. Some governments require that all state buildings become certified by the USGBC at a particular level, while others set a minimum facility size above which certification is required. Some ask that agencies follow the LEED design guidelines but do not require formal certification (DuBose, Bosch, and Pearce 2007).[28] From referencing such an established private standard in regulations, regulatory authorities are able to relieve the necessity to devise completely new and detailed requirements, and even save further cost in enforcing these requirements. However, it is not clear whether the regulated entities would accredit such referencing. As private voluntary codes or standards come to the public codes and even become mandatory, the regulated entities in fact lose discretion in the ways of reducing environmental impacts. First, how would these entities respond to the mandates of voluntary codes? Second, would this policy change promote more sustainable building construction in the longer term?

[28] For example, Boston, the first major city to include LEED in its municipal building ordinances, requires "all public and private development projects over 50,000 square feet earn either LEED Certified or successful review and approval through Boston Interagency Council Review (with the same LEED documentation and an optional 4 Boston-specific credits)" (USGBC, 2009).

To explain these puzzles, this study explores the political reactions of LEED-based policies. This objective coincides with the recent theme of policy feedback studies devoted to understanding how "new policies create new politics" (Pierson, 1993) and how existing policy legacies shape subsequent policy changes. According to the policy feedback scholarships, policy choices at t_1 have social consequences that reshape actors' preferences or capacities at t_2 in ways that either strengthen those policies' base of political support and expand the supportive coalitions, or diminish it and grow the opposition coalitions. Likewise, there are two main types of feedback effects that exist in the LEED accounts: self-reinforcing and self-undermining (Beland 2005; Oberlander and Weaver 2015). Some jurisdictions, after their first adoption of a LEED mandate, decided to reinforce it by broadening its administrative and regulatory scope. Some other jurisdictions, in contrast, might choose to undermine it through the act of repealing or adopting more industry-friendly green building standards, such as the Green Globes. However, these competing tracks of policy decisions have not been well resolved in the LEED literature. Neither have feedback studies systematically theorized and empirically tested the mechanisms through which self-undermining or self-reinforcing feedback effects emerge.

The LEED case provides a valuable lens through which to consider the feedback mechanism and its measurement. I test policy feedback effects in this study through an assessment of the LEED-based policies adopted by U.S. states across the period of 1996-2020. My empirical model examines the extent to which policy adoption yielded a change in politics. I compare lobbying registration records of states before and after the policy adoption of LEED with the records of a set of states that did not make such changes over the same time period. Since most quantitative studies of policy feedback theory come from the analysis of policy effects on mass publics and political participation, this measure of interest group mobilization adds methodological contribution to the literature and informs those interested in seeking quantitative evidence of policy feedback effects. Moreover, the results show that policy adoptions of the private voluntary program, LEED, can impact interest group involvement in lobbying activities. However, this impact varies depending on the contextual and design elements of the adopted policy. This contributes to the growing understanding of local governments as innovators in aspects of environmental governance that are beyond the scope of the traditional government-led command-and-control instruments.

4.2. The Complexity of Policy Feedback Effects

The policy feedback scholarship centers on the continuous interactions between policy change and political process, and it provides potential explanations of how the LEED standard prospered in subnational public mandates. Building on historical institutionalism and rational choice, the study of feedback addresses the process of how existing policies restructure politics and subsequent rounds of policymaking (Béland and Schlager 2019; Mettler and Sorelle 2014; Pierson 1993). In particular, the feedback literature largely devoted its attention to mechanisms through which policies, once created, reshape the state and social actors' goals and alliances over long periods of time in ways that affect subsequent policymaking (Edmondson, Kern, and Rogge 2019; Mettler and Sorelle 2014; Skocpol 1995; Weir et al. 1988). In his seminal work, Pierson (1993) describes two types of feedback mechanisms that shape policymaking processes and political conditions: the resource effects and interpretive effects. The former considers the

resources that policies bestow upon target groups (Patashnik and Zelizer 2009; Pierson 1993). Policies are producers of resources and incentives that influence the strategic behaviors of political actors. In contrast, the interpretive effects consider policies as sources of information that affect actor cognition and understanding through political learning, thereby creating or changing visions and expectations of actors (Mettler and Soss 2004). For instance, actors' perceptions of sustainability can influence their investment decision and commitment to innovative activities. In recent years, building on these two factors, Patashnik and Zelizer (2013) propose institutional effects as the third mechanism that draws attention to whether the enacted policy is invited by existing institutions and arrangements. This third type of feedback effects emphasizes the consistency between new policies and existing arrangements to strengthen policy support. Above all, resource effects, interpretive effects, and institutional effects collectively decide the effectiveness of policy enactment and entrenchment.

Understanding and anticipating the directions of policy change is an overarching issue. Early on, feedback literature based on historical institutionalism emphasizes the positive or self-reinforcing feedback effects. These studies argue that through shaping the distribution of material resources and influencing the cognition of political interests, regulatory officials and mass publics, enacted policies are able to create conditions for their own stability over time (Béland, Rocco, and Waddan 2019). However, scholars increasingly come to appreciate that policies can also have negative and mixed effects, where "self-undermining" rather than "self-reinforcing" is happening(Fording and Patton 2020; Oberlander and Weaver 2015). Hacker (2004) and Thelen (2004) stress that institution researchers should focus not only on stability and path dependency, but should also engage in the exploration of whether and how path-departing and transformative change emerge over time. Recent research has sought to identify some specific conditions that determine whether feedback effects are self-reinforcing, self-undermining, or a mix of the two (Fording and Patton 2020). However, there has been less progress in empirically determining if these feedbacks occur or the conditions under which they may or may not.

Examining the impact of positive or negative feedback is especially important to understanding the initiation and subsequent changes of LEED policies. It was possible that mandating a voluntary private program would result in some backlash among conservative opposing groups and it is likely that these negative feedback effects would have important political consequences. To understand how and whether these political consequences have affected policymaking, I look at the connection between LEED expansion and the political activities of related interests.

4.3. LEED and Policy Feedback

The enactment of the LEED standard in 1998, was one of the most significant events in global green building practices. Over the last decades, it has become an accepted industry practice and stimulated a transformative force within the building sector. Apart from the remarkable number of certifications, LEED creates new markets. For example, before LEED, materials like low-volatile-organic-compound (VOC) paints and green cleaning products were virtually nonexistent, but with the promotion of LEED, these products are already in widespread use. Similarly,

various green technologies and energy-efficient products have become available in both the commercial sector and the residential space. As the USGBC says in its report, the LEED practices have "the potential to yield great economies of scale by driving demand for materials and technologies as well as the resulting expansion of expertise" (2011, p. 4). A clear sign is the exceptional increase in market demand for green buildings in the last two decades. The general public and elected officials have gradually recognized the functions of green buildings in addressing cumulative and long-term hazards to human and environmental health. This recognition gives rise to widespread community conversations that begin in city halls, at neighborhood centers, and in public meetings. These community dialogues have resulted in a wave of public policy actions.

The LEED rating standard, as a private program, has been formally adopted by local- and state-level governments to produce more green buildings. By the end of 2019, at least 181 municipal or township jurisdictions and 27 state governments have (or once have) signed executive orders or passed laws to mandate LEED as a tool for benchmarking higher performance green building practices. A typical LEED mandate code may require public buildings to achieve LEED Silver certification and all private buildings that receive financing from the government to achieve LEED Certified. Some jurisdictions may have employed various incentives to encourage construction of LEED buildings, "such as fee waivers or reimbursements, subsidized LEED fees, discounted energy star appliances, property tax abatement, awards, green loan funding, training, and permit fee reductions" (Trisolini 2010, 705).

The proliferation of LEED mandates in government building codes is an important step as state and nonstate actors work towards sustainable transitions of all buildings and construction sectors. Some jurisdictions, after their first adoption of LEED, decide to reinforce the mandate by broadening the administrative and/or regulatory scope. Consider two jurisdictions' experiences. In July 2005, Colorado Governor Owens signed an executive order requiring all state buildings to incorporate LEED-NC practices. Later in April 2007, his successor Governor Ritter raised the executive order by signing the legislation requiring any new or renovated buildings whose total project cost includes 25 percent or more in state funds to be designed and built to the LEED standard. Likewise, in December 2007, Washington, D.C. passed legislation requiring all new government facilities constructed in the metropolitan area that earn LEED Silver certification and all new private commercial development that earn LEED Certified. In March 2012, the legislation was updated to include public schools in the regulatory scope which requires the Gold level of LEED for schools and imposes fines on private commercial buildings that do not provide proof of LEED certification within 2 years of receipts of occupancy.

However, jurisdictions may also choose to undermine the building policies even after a LEED preferred mandate has been in place. As the LEED certification gets increasingly popular, the opposition is also ramping up. Considering a large part of their product is unrecognized by the LEED standard, some industries – primarily comprised of conventional timber, plastics, and chemicals – frown upon LEED's expansion. These industry groups have endeavored to lobby against the use of LEED in government projects. They push their local or state governments to ban new constructions built with public money from seeking "any green building certification … that doesn't treat all certifications for (construction) products equally" (Badger 2003). Take Maine as an example. Maine was one of the earliest jurisdictions that mandated LEED in its

public building codes: in November 2003, Governor Baldacci issued an executive order requiring all new and existing state buildings to incorporate LEED guidelines. For a while, Maine kept building new state-owned buildings to LEED standards. However, since the wood produced by the jurisdiction's timber industry did not meet the LEED-approved FSC standards, Governor LePage signed another executive order in 2011 that banned the use of LEED in state funded constructions (Laskow 2011). Similarly, in June 2008, Flagstaff City adopted legislation requiring all new municipal buildings to earn a minimum of LEED Silver certification. Yet this law was repealed in 2014 and replaced with more relaxed legislation that only required municipal buildings of more than 10,000 sq. ft to be LEED Silver certified whereas 3 Green Globes and the Living Building Challenge are also acceptable. These jurisdictions provide examples of LEED mandates in public building codes that yield consequences that, over the long run, erode their own political viability.

Overall, there seem to be two main types of policy feedback that exist in the LEED mandate accounts: self-reinforcing and self-undermining. However, whether some jurisdictions adopt (or ban) LEED, and how this relates to other public and private practices has not been well resolved in the literature. Jacobs and Weaver (2015) acknowledge that policy feedback on its own is not the only source of policy stability or volatility. However, feedback studies have not systematically theorized the mechanisms through which self-undermining or self-reinforcing effects emerge and the conditions under which those mechanisms are most likely to operate. In the remainder of this article, I seek to identify some institutional conditions through which different directions of feedback are likely to emerge.

4.4. Hypotheses

According to the classic scholarship of policy feedback theory, policy enactment can influence the formation of political coalitions through mechanisms such as resource and interpretive effects (Pierson 1993). First, by conferring resources and incentives on some target groups, policies can shape the rate and direction of interest group activities. Pierson explained this line of effects: "major public policies constitute important rules of the game, influencing the allocation of economic and political resources, modifying the costs and benefits associated with alternative political strategies, and consequently altering ensuing political development" (1993, 596). That is to say, the enactment of public policies often changes the societal distribution of some critical material or political resource, thus usually making some groups feel rewarded but other groups feel "punished". For example, to promote green building development, policymakers may publish a mandate requiring buildings to reduce energy use to a certain extent, provide economic incentives such as grants, tax credits, and loans, or simplify administrative procedures to shorten the application time for green building construction permits. These policies take different forms and change the allocation of resources. Take the case of mandates for example. The most direct result of this policy is that builders or owners have to bear the costs of building upgrades to meet the public requirements. This may incite different responses from related groups. First, the builders may raise the sale prices or rents to make up for their costs. Some residents may be happy with the upgrade but some other residents may be more frustrated with the higher pay. Second, to meet the new energy requirements, the builders may choose to change their use of building materials. Subsequently, producers of the original materials would undertake market

loss, but new material owners may harvest a huge financial gain from the new mandate. Consequently, construction material producers may shift away from reliance on low-efficiency materials and increase investment in green technologies to promote construction advancement. In this way, policies change the allocation of resources and influence actor activities and strategies in ways that stimulate changes towards sustainability.

Meanwhile, the interpretive effect also plays a role in policy feedback. Policies often communicate the regulatory authorities' values and expectations, and can potentially change patterns of actor cognition. For example, the enactment of an environmental policy not only provides guidance for sustainable practices but also gives an indicator of market trends. It establishes expectations about future resources that are beneficial to some individual actors. In this process, if the actors perceive the policy instruments as providing insufficient resources to achieve their desired policy objectives, they may respond with lobby activities. However, vested interests who benefit more from the policy instruments are likely to take actions with compatible levels to protect their acquired "privileges" (see public thermostat theory for a more detailed description: Jennings, 2009; Wlezien, 2004). As Pierson has put it, "public policies often create 'spoils' that provide a strong motivation for beneficiaries to mobilize in favor of programmatic maintenance or expansion" (1993, 599). Thus, when there is an inconsistency between policy realities and stakeholder expectations, different interests are likely to engage in political activities to obtain or protect their resources. Above all, the resources and interpretive effect together indicate the mobilization of related interests as a response to policy change.

Like any other issues in the area of sustainability transitions, multiple interests containing both supportive and opposing voices are involved in the public mandates of the LEED standard. From the sustainability side, the mandates offer administrative or fiscal benefits to create favorable markets for green building construction and send a strong signal of government ambitions in green investment. These policies are likely to stimulate demand and interest in pursuing green development and open the gate for environment supporters to participate in more policy discussions. If this happens, subsequent amending policies are likely to break out. However, in the real world, no change or undermining changes are also likely to happen.

Since the LEED standard does not endorse a wide range of forestry and chemical products in the U.S. building market, such mandates have been strongly attacked for legitimacy and justice. As a response to the nationwide spread of LEED in public policies, many companies and trade associations have formed an anti-LEED coalition front group and have actively lobbied in favor of the banning order of LEED use for federal and state projects. As a response, the LEED supporters may engage in a higher level of political mobilization to match that of the opposing power. In this situation, one is likely to see an upsurge in political activities from both the supporting and opposing groups after the public adoption of LEED mandates. However, if there is little opposition emerging compared with the supporting group, the supporting group will not significantly increase their activity level. Depending on the consistency of their expectations and the policy realities, the LEED-preferred groups would strategically match their activity level with the inconsistency. That is to say, if the policy is already strong enough, they will maintain or even decrease their level of political activities. In contrast, if the policy is below their expectations, they would at least maintain or increase political mobilization to achieve their policy objectives. To reflect the activities of the interests regarding the LEED mandates, this

study inspects lobbying activities which are often considered an important influence on legislative and government policy outcomes, and it assumes

> **Hypothesis 1a**: Imposition of LEED requirements in state policies will increase the lobbying activities of related interest groups.
>
> **Hypothesis 1b**: Imposition of LEED requirements in state policies will decrease (if any) the lobbying activities of related interest groups.

Though it is well argued that policy decisions can produce resource and interpretive effects, how resources are allocated and how policy objectives are communicated reshape actor behaviors. The institutional perspective pays more attention to policy design and institutional context that is not adequately addressed in the resource or interpretive mechanisms. Indeed, according to the institutional perspective, policy change can be considered as part of the changes of institutional structures that may otherwise support or contradict the existing regime. Suppose a jurisdiction decides to mandate the private voluntary LEED standard for its buildings, it will probably face the challenge of maintaining political support because the LEED mandate might threaten or impose losses on such vested interests as the industry and construction sector. If the threats are certain and salient, the vested interests become strongly motivated to engage in political opposition to protect their interests. In this sense, as the policy scales up with clear-stated policy preferences, vested interests from the opposing groups will be rising.

In contrast, a policy change with a weak design may not be able to create enough incentives for the mobilization of vested interest. According to Jacobs and Weaver (2015), when the policy in question involves an ambitious task of social engineering characterized by high causal complexity rather than a well-understood, incremental intervention, there is more uncertainty regarding the future of the policy. Patashnick and Zelizer (2013) indicate the high frequency of "symbolic policies" which are not designed to change society but simply as an opportunity to display policymakers' support for some popular causes without incurring the costs a substantive reform would entail. When a policy is created providing only meager resources, group feedbacks will likely be feeble. These two studies have highlighted that policies with different designs and forms have different effects on the resources and incentives of groups.

To look at the widespread LEED policies across the country, I employ policy intensity as a possible factor to determine the strength of policy designs. States impose a variety of rules and requirements in LEED-based policies, ranging from incentive only to the strictest forms of public mandate. As mentioned in Patashnik and Zelizer (2013), there is a hierarchy of institutional shifts, and the most robust changes involve the termination of an existing institutional structure. Since more socially ambitious policies provide a much-needed shift toward sustainability transitions, the absolute intensity of policy is more likely to be associated with an increase in political coalition activities. For the opposing groups whose economic interests suffer serious losses by the imposition of LEED requirements, the backlash tends to grow stronger over the escalation of the policy intensity. Thus, it seems that with the increase of policy intensity, the interest groups are going to increase their mobilization activities and the opposing group is going to challenge it more. The level of interest group mobilization can be proxied by lobbying registrations. Based on these arguments, I anticipate

Hypothesis 2: The stringency of the LEED policy is positively related to the number of lobby activities by relate groups after the state adopts this LEED policy.

4.5. Research Design

4.5.1 Data Illustration

This study uses panel data obtained from several sources to investigate the political effects of state-level adoptions of LEED-based policies. The dependent variable is the number of annual lobbying registrations performed by LEED policies' interest groups extracted from two datasets respectively compiled by a nonprofit organization OpenSecrets and a private company illumis. Since the interest groups need to be on the table to exert influence on the public policy making process, the number of lobbying registrations in the target issue area is a direct measure of the interest group's involvement in political activities. However, though lobbyists, by law, must fill out a registration document in every state, the information in the registration document varies widely from state to state.[29] Most states include information on lobbyist's name, registration date, and lobbying client's name and address, but the description of lobbying interests or subjects is usually missing. As one can imagine, most lobbying registrations focus on the issue areas more closely with resident welfare, such as healthcare and education. Based on the limited information provided on the state-level lobbying dataset, there is only a small part of total lobbying registrations could be directly related to green building, making it difficult to disentangle the green building policy effect.

To address this issue, I explored using lobbying subjects to extract the registration records that are more related to LEED policies. The lobbying subjects are defined as the subjects or issues the lobbyists and their clients intend to be lobbying on at the time they register. The subjects can be related to any topics the lobbying entities are interested in, such as agriculture, immigration, criminal justice, education, economic development, taxes, energy sources, ethics, veteran affairs, and many more. This data potentially can directly measure public interests and political activities in any given topic area. The information on lobbying subjects was available in 9 of the states (including Arizona, District of Columbia, Massachusetts, New York State, Ohio, South Carolina, South Dakota, Virginia, and Wisconsin) tracked by illumis. Table *4.1* shows more details of the lobbying subject data. In particular, the data covered varying periods of time from 2 years to 31 years. Only 3 of the 9 states had lobbying registration data available prior to the option of LEED policies. This means that a cross-state analysis of the relationship between LEED policies and political activities is not feasible with the readily available data. To accommodate the data problem, I employed Garlick and Cluverius's (2020) automated text classification method to estimate the lobbying subject for each interest group lobbying registration and then layer this classification over the datasets for a longer timeframe.

[29] See Sunlight Foundation's scorecard of state lobbyist disclosure requirements.

Table 4.1 Data availability of lobbying subjects

State	Data period	LEED policy ever	LEED policy year	# of lobbying registrations
MA	1990-2020	Yes	2007	87,285
AZ	1994-2020	Yes	2005	20,377
WI	2003-2020	Yes	2006	18,289
SC	2008-2020	Yes	2007	49,675
OH	2009-2020	Yes	2007	86,029
VA	2010-2020	Yes	2007	13,922
SD	2011-2020	Yes	2008	8,093
NY	2011-2020	Yes	2007	446,371
DC	2018-2020	Yes	2006	7,171

Specifically, I first worked with two undergraduate research assistants to code a sizeable number of lobbying subjects that were available in some states' registration forms. From July to October in 2021, 35,000 pieces of lobbying subject data were coded into 2 categories: construction, and others.[30] The student assistants were trained two weeks before the formal start of data coding, and the inter-coder reliability estimates were 65.2 for kappa statistic and 94.4 for percent agreement. [31] Based on the coded lobbying subject data from the 9 states above, I trained a Naïve Bayesian algorithm in R to effectively code each lobbying client's name to a dummy variable: 1 for Construction and 0 for Others. The overall prediction accuracy is 0.7445 with a 95% confidence interval of [0.7366, 0.7523]. The dependent variable is ultimately the number of lobbying registrations related to construction issues in state i for a given year t, denoted by *Lobbying registrations*.

The key explanatory variable is *LEED policy*, which represents the adoption of LEED-based green building policies. It should be noted that this study only examines the first LEED policy adoption, and considers subsequent policy changes (if any) as important reflections of the policy feedback claims. It should also be noted that any LEED-based policies adopted within the three years of the first LEED policy were captured as part of the first policy change in time

[30] In practice, the research assistants coded the lobbying subjects into 5 categories including construction, environment, manufacturing, natural resources, and others. In particular, the construction category is used to include most of the interest groups directly with the advancement of green buildings; the environment category could capture the supportive coalition from the concern of sustainability; and manufacturing and natural resources both take into account the influence of green building policies on industries of construction-related materials, such as chemicals and wood. Since LEED guidelines have many restrictions on sources of construction materials, the inclusion of these two categories is crucial to gather information on the opposing coalitions of LEED policies. However, the inclusion of all these four categories could mess up the sample because of the large number of lobbying registrations related to the areas of environment, manufacturing, and natural resources but irrelevant with green buildings. Thus, only construction category coding was kept in this analysis.

[31] The training and coding protocol is available in the appendix.

sequence.[32] Specifically, a binary independent variable was included as to whether a state has initiated a LEED-based policy but has not started a second LEED policy change in a given year. As such, it was coded 0 for every state at the start of the sampled time period but turned to 1 if state i adopts a LEED-based policy at time t. Once the state i adopts a second policy change at time $t + n$, the state was dropped from the analysis because the political activities after $t + n$ would be more directly impacted by the second rather than the first policy change. The state-level LEED policy data were obtained from the USGBC's Public Policy Library and supplemented with information collected from state legislature websites.

Figure *4.1* provides a simple overview of the evolution of construction-related lobbying registrations 5 years before and after the adoption of LEED policies in 10 states. The x-axis represents the event window of the period from 5 years before each state's first LEED policy to 5 years after the policy event (Maneenop and Kotcharin 2020). The [-5, +5] events window covering 11 years of lobbying registrations was selected to balance the statistical needs of period length to track changes and the data limitations of key variables. The 10 states with available information covering the event window were separated into four groups, which are 1) the group with no LEED policies adopted ever, i.e., Georgia; 2) the group that adopted LEED policies only once without further policy changes regarding LEED, i.e., California, Delaware, Indiana, Minnesota, Oregon, and Washington; 3) the group that adopted and reinforced its LEED policy after 5 years of first adoption, i.e., Arizona and New Jersey; and 4) the group that adopted but undermined its LEED policy after 5 years of first adoption, i.e., Virginia. In particular, Georgia exhibits approximately no change in construction-related lobbying registration across the [-5, +5] event window. Meanwhile, for the no policy change group represented by California, the number of lobbying registrations increases before the year of their first LEED policy and slows down this increase in the post-policy period. As for the reinforcing group represented by Arizona, the most obvious finding should be that, right before their first-time LEED policy adoption, the number of lobbying registrations rises up swiftly and maintains this trend for three periods and then gradually slows down to flatten the curve. In contrast, the curve of Virginia, which undermined its LEED policy after its initial adoption, shows a moderate shift from upward to the opposite. Above all, this descriptive figure seems to validate the traditional argument that the political activities of interest groups could precede policy change. However, as for post-policy political activities, the figure reveals a subtlety with regard to interest group mobilization, which might contribute to subsequent policy changes as categorized in the analysis.

[32] States adopt LEED-based policies with different forms. For example, in 2011, California enacted Chapter 354 to allow expedited permitting and fee reduction for LEED-certified projects. Shortly in 2012, Governor Brown signed Executive Order B-18-12 which requires the all new and majorly renovated State buildings larger than 10,000 sq. ft. to obtain LEED Silver or higher. In 2013, California adopted the California Code of Regulations Title 4, which further exemplifies the tax incentives provided for LEED-certified buildings. Consider that green building codes are often updated every 2 or 3 years at the state and national level and we need to leave room for interest groups to respond to the enaction of a new policy, the first round of policy change was set to be 3 years.

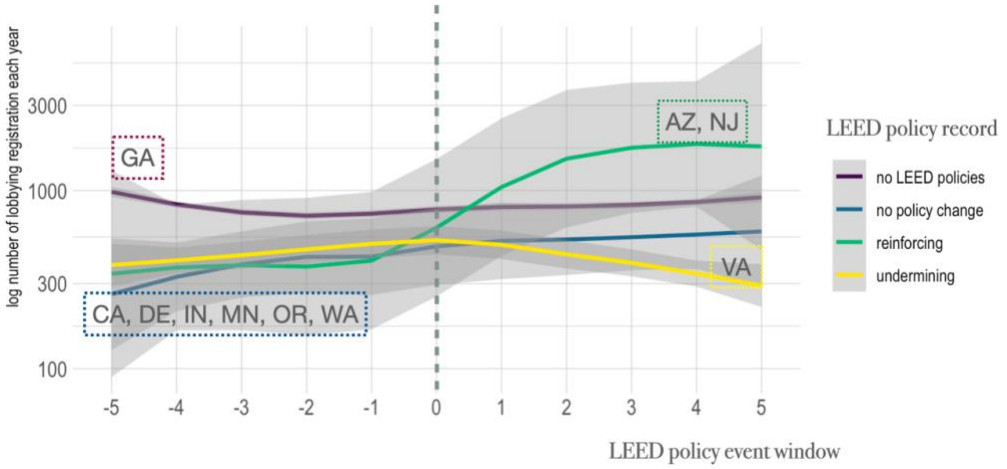


Figure 4.1 Number of construction-related lobbying registrations before and after LEED policies in 10 U.S. states, 1997-2020

To explore the heterogeneous responses of interest group activities as indicated in Figure *4.1*, Hypothesis 2 which assumes that the stringency of LEED policies may moderate the policy feedback effects were examined with separate independent variables broken down from the above policy variable. In particular, five policy design dummy variables were coded based on the requirements stated in the LEED policies. These include (1) *Policy mandated*, which was coded 1 if the LEED policy mandates LEED for public or state-funded buildings, and 0 if the LEED policy is incentive- or encouraged-based and nonbinding in nature; (2) *School specific*, which was coded 1 if the policy only applies to schools or special-use buildings such as data center, and 0 otherwise; (3) *Green Globes*, which coded 1 if LEED's competitor, Green Globes, is explicitly mentioned in the LEED policy as well, and 0 otherwise; (4) *Other certifications*, which was coded 1 if other third-party green building certifications are accredited in the LEED policy; and (5) *Incentive included*, which was coded 1 if any incentive strategies (such as property tax credit or exemption, expedited permitting process, and loan program) are adopted, and 0 otherwise. These separate dummy variables represent different features of LEED policy designs, and a policy with *policy mandated* equal to 1, and the other four variables all equal to 0 is considered the most stringent design in this analysis. All the policy variables were lagged by 1 year.

Moreover, a set of covariates were controlled for a variety of factors that have been found or argued to correlate with the number of lobbying registrations. There are four primary types of the covariates. The first is demographic variables. Data on total *Population* count and *Median household income* (in 2018 US dollars) for each state were obtained from the US Census Bureau. The second type relates to the measurement of a state's economy. This includes state *Tax revenues* reported in the Census's Annual Survey of State Government Tax Collections. Besides, state-level *Electricity prices* drawn from the International Energy Agency (IEA) were also included to control for public need and desire for green building practices. Third, political variables were examined by including state-level measures of *Voter turnout* from Census to control for political participation, and *Government ideology* scores reported by Richard C. Fording (2018) to control for the possibility that LEED policy reflects the general conservatism or liberalism of a state's population. Besides, I added the share of the state Gross Domestic Project (GDP) (in millions of current dollars) for the construction industry *(% gdp in*

construction), manufacturing industry *(% gdp in manufacturing*), and agriculture and forestry-related industry (*% gdp in forestry*) extracted from the US Department of Commerce. Since the key interest groups mentioned in news articles and comments often come from timber, chemical, and construction-related industries, these measures were meant to proxy their respective industries' significance in the state policy making process. Last, I also included two policy variables to capture the effects of existing LEED policies outside and within the state jurisdiction. First, a dummy variable, *Neighbor adoption*, was coded 1 if, for a given year t, any of the neighboring states of state i has ever adopted a LEED policy in year $t-1$. [33] Similarly, I calculated the number of cities or towns within state i that have already had LEED policies in year $t-1$, and this variable is denoted as *City adoption*. Some of these predictor variables were logarithmically transformed and/or standardized to accommodate possible skewness and isolate the contribution of each variable, such as *Population, Median household income, Tax revenues, Electricity prices, Voter turnout, Government ideology, % gdp in forestry, and City adoption.* Moreover, Kalman smoothing recursions (Kalman 1960; Moritz and Bartz-Beielstein 2017) were applied to impute a small percent of missing values that existed in the original covariate data.

4.5.2 Estimation Method

Table *4.2* presents the summary statistics of all the variables included in the analysis. This data includes 50 US states covering a sample period of 1996-2020. However, as shown in Table *4.2*, significant missingness exists in the outcome and policy variables. Limited by the data structure, a comprehensive causal analysis is not feasible in this context. To accommodate the data problem, I employed both parametric and nonparametric tests for the analysis.

First, the nonparametric Mann-Whitney U test was used to establish the statistical significance (α=.05) of differences between annual lobbying registration counts of different comparison groups. Fundamentally, the Mann-Whitney U test is a test of dependency between treatment and outcome variables. First, a treatment splits the sample in two or more groups. Then this nonparametric test compares the averages of the outcome variable for the comparison groups and assumes that differences in the average of the outcome variable are caused by the defined treatment. In this analysis, I defined two treatments. First, I built a within-state pre-post comparison and the treatment was LEED policy adoption. Second, I moved beyond the within-state analysis and employed treatment-control pre-post analysis with different treatments defined by LEED policy adoption in the general sense and five specific policy features. Specifically, I examined states that once adopted LEED policies but with different LEED policy features, and I compared them with the states that never adopted LEED policies. Since my outcome variable, the count of lobbying registrations, is highly skewed, median values were chosen for the tests to more appropriately represent the population (Baek 2018; Melo and Wolf 2005).

Following the nonparametric test, multivariate regressions were conducted to describe a more sophisticated relationship between political activities and policy adoption variables. To estimate the count of lobbying registrations in each state for each year, I employed a fixed effects negative binomial specification, where the fixed effects are defined at the year and state level to capture any jurisdiction or year specific omitted variables.

[33] The neighboring state information came from a public resource on GitHub (Ubikuity 2021).

Table 4.2 Descriptive statistics

	Obs.	Mean	Median	Min.	Max
Outcome Variables					
Lobbying registration	899	670.00	326.00	0.00	18,710.00
Policy Variables					
LEED adoption (lag)	1107	0.31	0.00	0.00	1.00
Policy mandated (lag)	1107	0.15	0.00	0.00	1.00
School specific (lag)	1107	0.04	0.00	0.00	1.00
Incentive included (lag)	1107	0.10	0.00	0.00	1.00
Green Globes (lag)	1107	0.09	0.00	0.00	1.00
Other certifications (lag)	1107	0.12	0.00	0.00	1.00
Covariates					
Demographic Covariates					
Population	1250	5.82E+06	4.02E+06	4.93E+05	3.96E+07
Median household income	1250	5.89E+04	5.81E+04	3.49E+04	8.50E+04
Economic Covariates					
Tax revenues	1250	1.42E+07	8.57E+06	7.11E+05	1.88E+08
Electricity prices	1250	26.90	25.03	11.43	99.96
Political Covariates					
Voter turnout	1250	45.92	45.50	30.10	71.16
Government ideology	1250	45.82	46.67	17.51	73.62
% gdp in construction	1250	0.04	0.04	0.01	0.11
% gdp in manufacturing	1250	0.12	0.12	0.00	0.31
% gdp in forestry	1250	0.02	0.01	0.00	0.12
Policy Covariates					
Neighbor adoption (lag)	1250	0.33	0.00	0.00	1.00
City adoption (lag)	1250	3.43	1.00	0.00	69.00

Note: the above statistics shows the original data statistics before logarithmical and z-transformation.

4.6. Results

4.6.1 Nonparametric Mann-Whitney U test

To illustrate the impact of LEED mandates on lobbying group registrations, I first conducted a pre-post treatment analysis. The sample was limited to states that once adopted LEED-based policies during the study period of 1996-2020. The year of LEED policy adoption divided my panel data's state-year observations into two groups: pre- and post-policy observations. Figure 4.2 presents the median numbers of annual lobbying registrations for each of the 34 states. From the boxplot, states seem to increase their construction-related lobbying registrations after a LEED policy adoption. The results of the Mann-Whitney test in Table *4.3* show that there is a statistically significant median difference between the pre- and post-policy observations for the 34 states that once adopted LEED policies. However, this preliminary result disregards the highly possible fact that the annual number of lobbying registrations tends to increase with time.

Table 4.3 Statistical results of the Mann-Whitney U test (pre-post design)

Number of States	Number of Observations	Difference	Significance	95% CI
34	459	140	0.000	[87.000, 193.001]

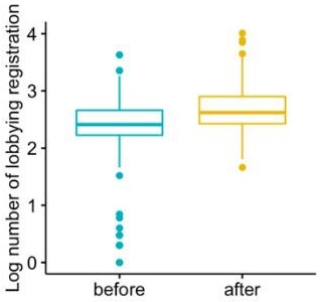


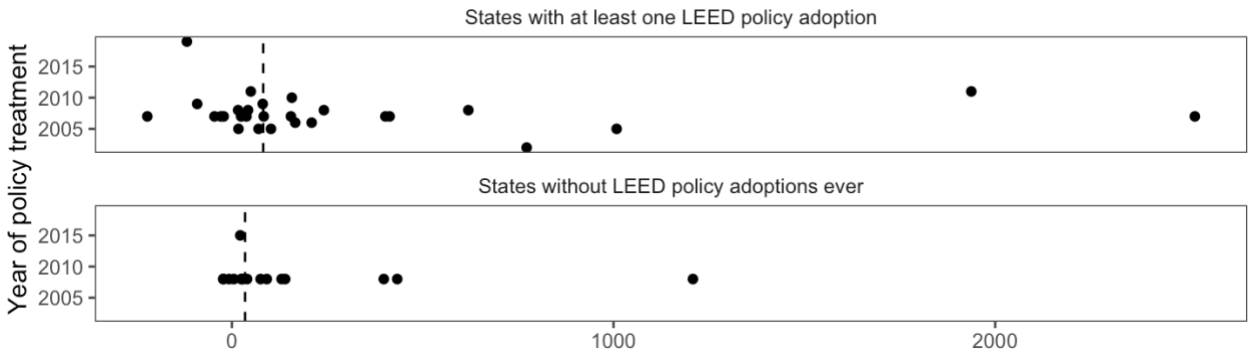
Figure 4.2 Within-state lobbying registration changes

To address this concern, I employed the pre-post treatment-control design to take into account the existing trajectory of lobbying registration changes. First, all the states were divided into two fundamental groups based on their adoption records of LEED policies. The base control group consists of states without any LEED policies from 1996 to 2020. 16 states were categorized into the base group and the other 28 were in the general treatment group. [34] Based on the information on policy adoption years, observations for states with at least one-time LEED policy adoptions were further split into pre-policy and post-policy units. Then, I calculated these states' outcome gains by subtracting their respective median number of pre-policy observations from the median number of post-policy observations. As for the outcome gains of the base control group, I assumed a counterfactual LEED adoption year which was equal to the median adoption year of the general treatment group. The counterfactual LEED adoption year was set to be 2007. The outcome gains for the base group were the median numbers of post-policy observations subtracted by the median number of pre-policy observations.

Figure *4.3* plots the outcome gains for each of the 44 states. States with LEED policy adoptions have a higher median outcome gain in lobbying registrations compared with states without any LEED policy adoptions.[35] This seems to support Hypothesis 1a which argues that LEED-based policies will increase the lobbying activities of related interest groups. However, more advanced statistical analysis is needed to draw any conclusion.

[34] Arkansas, District of Columbia, Hawaii, Maryland, Maine, and Nevada were not included due to data missingness.

[35] However, the plots of the outcome gains seem to be overly dispersed. This conclusion is descriptive and far from being general.



Note: The vertical dashed lines represent the median outcome gains for each group

Figure 4.3 Outcome gains of LEED policy adoptions

The first result in Table *4.4* statistically tested the outcome gain difference between the states with and without LEED policy adoptions. However, in contrast to the above findings, there was not any significant difference between the two groups. This null result meets my concerns about the existing rising trend of lobbying registrations as well as the possible heterogeneity of the outcome gains. To examine the association between outcome gains and the policy design variables, I adopted similar procedures to conduct different treatment groups based on the design of the adopted LEED policies. As shown in Table *4.4*, most of the design variables were positively associated with positive outcome gains except the design requirements that include Green Globes in the policy. This meets my expectation that more industry-friendly policies are less likely to relate to the increase of lobbying registration. However, these findings are not strongly supported in statistics.

4.6.2 Multivariate Regression Tests

Though null results were found in the nonparametric tests, they empirically contribute to the understanding of the policy effects on political activities especially when data availability limits the sample size in an analysis. As mentioned above, there is a significant concern of data missingness for the lobbying-policy dataset. First, many states did not track the records of lobbying registrations until around 2006. Therefore, a large number of states adopted LEED policies before their first available record of lobbying registrations. Further, due to the policy feedback nature of this study's research question, when states adopted a second policy change, they should be moved out of the sample. As a result, data missingness of policy data was arbitrarily introduced as well. This data problem limits the statistical power of the traditional panel data analysis. To ameliorate this problem, I limited my sample data period to 2006-2020. In this way, the percent of missing data was able to drop from 28% to only 2%. Since the earliest state-level LEED-policy emerged in 2001 (when the Governor of Maryland signed an executive order to introduce LEED as a model for the state's High Efficiency Green Building Program), this new sample dropped 10 "early adopters", and thus more likely to reflect the political reactions in the "late adopter" states. Since interest groups tend to grow gradually across time, the political responses of late adopters are in fact likely to be stronger than a general finding

related to all the adopters in records. So, caveats should be placed on the interpretation of the regression results with a shorter period of 2006-2020.

Table 4.4 Statistical results of the Mann-Whitney U test (pre-post treatment-control design)

Comparison Groups	Number of States	Number of Observations	Difference	Significance	95% CI
states with no LEED policy adoptions ever vs. states with at least one LEED policy adoption	44 (16:28)	894	24.490	0.518	[-58.904, 131.343,]
states with no LEED policy adoption ever vs. states with LEED mandates	34 (16:18)	850	6.909	0.878	[-95.192, 97.088,]
states with no LEED policy adoption ever vs. states with LEED encouraging/incentive policies	26 (16:10)	650	67.557	0.263	[-68.192, 283.164,]
states with no LEED policy adoption ever vs. states with LEED policies in favor of Green Globes	25 (16:9)	625	-13.546	0.718	[-123.269, 79.441,]
states with no LEED policy adoption ever vs. states with LEED policies towards specific building projects (e.g., public schools)	20 (16:4)	500	227.4167	0.178	[-51.082, 642.220,]

Table *4.5* reports the results of estimated associations between LEED policies and subsequent changes in construction-related lobbying registrations. While state fixed effects were included in all of the four models, I made some distinctions for the year fixed effects. Specifically, models (1) and (3) controlled for the year of lobbying registrations, but models (2) and (4) controlled for the year of states' first LEED policy adoptions. This year effect difference did not show too much difference regarding the findings. Models (1)-(4) show that LEED policy is generally not associated with a change in subsequent lobbying registrations. Rather, some of the requirement designs of the LEED policies are shown to be significantly associated with the outcomes. In particular, when the enacted policy is mandatory, there are likely to be more lobbying registrations within the state. However, it is unexpected to find *school specific* to be statistically significantly positive with the number of subsequent lobbying registrations. It might be because that the public LEED policies targeted at schools are more stringent than in the other areas. Further analysis is required to draw more implicative conclusions.

Table 4.5 Negative binomial results of the relationship between LEED policies and subsequent political activities (2006-2020)

Variables	(1)	(2)	(3)	(4)
IV: Policy variable:				
LEED adoption	-0.103	-0.118	-0.095	-0.106
	(0.081)	(0.084)	(0.080)	(0.082)
Policy mandate	0.315***	0.248**	0.308***	0.294***
	(0.080)	(0.083)	(0.079)	(0.080)
School specific	0.322**	0.306*	0.338**	0.344**
	(0.119)	(0.124)	(0.118)	(0.120)
Other certifications	-0.108	-0.159	-0.098	-0.090
	(0.105)	(0.110)	(0.104)	(0.106)
Green Globes	0.037	0.092	0.001	-0.017
	(0.110)	(0.114)	(0.109)	(0.111)
Incentive included	-0.034	-0.046	-0.035	-0.079
	(0.071)	(0.074)	(0.069)	(0.071)
Covariates				
Population			-5.162***	-2.274
			(1.283)	(1.164)
Median household income			0.018	0.006
			(0.017)	(0.015)
Tax revenues			0.814***	0.985***
			(0.211)	(0.197)
Electricity prices			-0.580	0.253
			(0.394)	(0.344)
Voter turnout			0.017	0.017
			(0.017)	(0.014)
Government ideology			0.022	0.002
			(0.014)	(0.132)
% gdp of construction			4.221	4.898*
			(2.449)	(2.203)
% gdp of manufacturing			2.277	1.091
			(1.543)	(1.443)
% gdp of forestry			-0.015	-0.027
			(0.019)	(0.016)
Neighboring adoption			-0.040	-0.045
			(0.052)	(0.051)
City adoption			0.285*	0.393***
			(0.113)	(0.100)
Constant	4.742***	4.825***	30.269***	11.013
	(0.094)	(0.087)	(7.407)	(6.363)
Obs.	731	731	731	731
Period	2006-2020	2006-2020	2006-2020	2006-2020
Year fixed effect	Yes	No	Yes	No
Adoption year fixed effects	No	Yes	No	Yes
State fixed effects	Yes	Yes	Yes	Yes
AIC	9367	9409	9318	9327

Note: Estimation results with standard errors in parentheses. Significance is indicated by *, ** and *** for the 5, 1 and 0.1% levels, respectively.

The control variables exert some noteworthy effects as well. For example, the state government's tax revenues, rather than the median household income, are positively associated with the increase in construction-related lobbying registrations. The state tax revenue refers to the total compulsory contribution exacted by the state government for public purposes, excluding noncash sources (Cidell and Cope 2014). Since public construction is a large part of government expenses, this finding shows that people actively pay attention to public spending of the state government and are willing to express their pursuits with political activities. Second, the results validate the multilevel governance argument that local-level policy innovations are likely to influence state-level policies. Local-level and multilevel analysis of LEED policies can be another interesting topic for policy scholars to explore.

Table *4.6* shows the negative binomial regression results of the same models but with the complete time period of 1995-2020. In this new sample, some strong associations became less consistent, such as tax revenue and city adoptions. Rather, some new relations are shown in the models like other certification, population, and voter turnout. However, *public mandate* is still statistically significant in the models and positively related to post-policy lobbying registrations.

4.7. Alternative Evidence

Above all, this study has made a variety of attempts to address the data barrier for a valid statistical test of pollical responsiveness to LEED policies. Though drawbacks existed in these different methods, the analysis makes the first attempt to address such a policy feedback problem with a pilot case of LEED. To further validate my hypothesis and the analysis, this section will provide some descriptive evidence to show how LEED policies can have an impact on interest groups' political activities, and subsequently lead to different results of second policy change.

To start with, Maine was among the earliest states that adopted LEED policies in their public building codes. In 2003, Maine Governor John Baldacci issued an Executive Order directing all new or existing state buildings to incorporate LEED guidelines, provided that standards can be met on a cost-effective basis. For a while, Maine was building new state-owned buildings to LEED standards. However, this order received ample backlash from the lumber industry. Maine has lots of trees, and the vibrant timber industry within the state wasn't producing wood that met the LEED-approved Forest Stewardship Council (FSC) standards. In 2011, Governor Paul LePage acted to repeal the 2003 order and required green building certifications to incorporate three forestry standards that met the needs of the timber industry. The timber industry was meant to push forward an explicit ban order for the LEED. Though unsuccessful for an explicit ban, this updated green building policy removed LEED from the state policies and weakened its standing within the state. Similar stories were reported in many other states, such as Virginia, North Carolina, and South Carolina.[36]

[36] Interestingly, though many news articles and blogs have mentioned the heated opposition in Ohio, the state failed to pass the anti-LEED bill into law.

Table 4.6 Negative binomial results the relationship between LEED policies and subsequent political activities (1996-2020)

Variables	(1)	(2)	(3)	(4)
IV: Policy variable:				
LEED adoption	-0.206	0.055	-0.202	-0.194
	(0.118)	(0.137)	(0.120)	(0.124)
Policy mandated	0.443***	0.422**	0.470***	0.476***
	(0.119)	(0.139)	(0.120)	(0.125)
School specific	0.265	0.385*	0.280	0.415*
	(0.165)	(0.194)	(0.169)	(0.175)
Other certifications	-0.367*	-0.372*	-0.342*	-0.345*
	(0.153)	(0.180)	(0.153)	(0.161)
Green Globes	0.169	0.212	0.094	0.034
	(0.164)	(0.192)	(0.164)	(0.171)
Incentive included	0.099	-0.049	0.105	0.003
	(0.103)	(0.120)	(0.103)	(0.107)
Covariates				
Population			-5.823***	-4.135**
			(1.446)	(1.432)
Median household income (rescaled)			0.021	0.059**
			(0.024)	(0.022)
Tax revenues			0.404	1.317***
			(0.336)	(0.306)
electricity price			0.048	2.513***
			(0.599)	(0.473)
Voter turnout			0.056*	0.062**
			(0.025)	(0.021)
Government ideology			-0.009	-0.005
			(0.021)	(0.020)
% gdp of construction			0.710	5.254
			(3.686)	(3.301)
% gdp of manufacturing			2.113	-2.992
			(1.639)	(1.593)
% gdp of forestry			0.044	0.005
			(0.027)	(0.024)
Neighbor adoption			0.110	0.012
			(0.075)	(0.077)
City adoption			0.096	0.447***
			(0.111)	(0.106)
Constant	2.320***	4.825***	33.435***	16.019*
	(0.242)	(0.161)	(8.356)	(7.742)
Obs.	896	896	896	896
Period	1996-2020	1996-2020	1996-2020	1996-2020
Year fixed effect	Yes	No	Yes	No
Adoption year fixed effects	No	Yes	No	Yes
State fixed effects	Yes	Yes	Yes	Yes
AIC	12077	12334	12042	12092

Note: Estimation results with standard errors in parentheses. Significance is indicated by *, ** and *** for the 5, 1 and 0.1% levels, respectively.

4.8 Discussion and Conclusion

This study makes an important attempt at understanding policy feedback theory and pursuing a valid method to test this theory empirically. By discussing how existing policy legacies shape subsequent politics and policymaking, the policy feedback theories are able to track and explain policy evolutions differently from other policy process theories. However, the systematic study of how policies have feedback effects on a variety of political processes has increased rapidly only within recent years. So far, quantitative evidence on how policies actually affect politics is very limited. In this chapter, I used LEED as a pilot case and explore different estimation techniques to address two of the major barriers in the empirical tests of policy feedback: data availability and measure validity. The results underscore the role of institutional context to interpret policy effects over time. Following the institutional perspective mentioned in Patashnik and Zelizer (2013), policy feedback effects are more likely to be shaped by the institutional bases of potential followers and opponents of the enacted policy.

Using panel data from a set of states across the U.S., I modeled whether and how, once passed, public regulation surrounding LEED certification can create new politics within the jurisdiction. I employed estimates of the number of groups registered to lobby as an outcome variable, and the policy adoption of LEED policies as well as the requirement designs of the policies as the independent variables. To address the data limitation problem, I adopted machine learning techniques to limit the policy outcomes to the lobbying registrations that are specifically related to construction issues. My empirical model examined the extent to which LEED policy adoption could yield a change in politics. I used the Mann-Whitney U test to compare interest group mobilization records of states before and after the policy adoption of LEED with the records of a set of states that did not make such change over the same time period. The results show a null relationship between LEED policies and lobbying activities, which could be major because of the co-existence of positive and negative feedback effects among the U.S. states. The results of the multivariate count regressions validate this assumption to some extent because the policy designs of mandates are consistently found in regression models to be positively and statistically associated with post-policy lobbying registrations.

However, I need to add a caveat that this analysis is only able to empirically test whether an enacted policy is associated with, rather the causes of, the political activities afterward. This study is a pilot attempt and may not be adopted to general or widespread cases, but it could potentially be more helpful in more salient or high-profile topics such as health care and education concerns. However, since my proxy of feedback effect – the number of construction-related lobbying registrations after LEED policy adoption - is directly related to the political activities of crucial interest groups, this measure is worth a further discussion of its validity in testing the feedback theory.

To improve this study and extend the scope, I suggest a number of factors to be considered when analyzing the feedback effects between public and political actions for green buildings. These factors are considered in what follows in analyzing public adoptions of private green-building standard, whether the requirements impact the political support to the policy, and whether the political support feed back to the policy and produce subsequent changes of the state policy on green building development. My empirical model examines the effects of LEED policies on lobbying activities, and it directs future works to explain why some jurisdictions

adopt more progressive or restrictive policies after their first promotion of the green building LEED standard. Building on the analysis of Pierson (1993) and Patashnik and Zelizer (2013), scholarly attention could be possibly paid to the stringency of LEED initiatives, the existence of building energy codes in public regulations, and the rate of private adoptions of LEED within the jurisdiction.

Finally, this study might also contribute to the VEP literature because it indicates an investigation of the relationship between the public mandatory regime and private voluntary instruments. Voluntary environmental programs, like LEED, are mechanisms for firms and organizations to signal their environmental stewardship to their stakeholders without a compulsory bond with the regulatory authorities. However, when LEED becomes a mandate, the signaling benefits from the same level of LEED certification seem to decrease because society's average standard of sustainability is raised due to the public mandates. To maintain the differentiating status from their peers, buildings may either invest more to get a higher certification level or compete with new entrants to the green building market. If we hold all else equal, the private actors are not likely to be happy with the mandates of a voluntary private code. Then what are the mechanism to explain voluntary programs turning to be mandatory? In this process, whether it is public regulation that mandates the voluntary codes, or it is the voluntary program that pursuit to be integrated into the mandatory codes? The interactive relationship between public and private regimes is still worth investigating.

Chapter 5 Conclusion

Over the past decade, environmental concerns have risen dramatically. Scholars and policymakers increasingly recognize that a broad array of regulatory instruments is required and desired to manage the environment. Policies built on regulation by centralized government agencies, with top-down creation and implementation of rules imposed on businesses and utilities, have generated considerable dissatisfaction due to administrative burdens, technological rigidity, and imperfect compliance (Brewer & Stern, 2005; May, 2005). This dissatisfaction has drawn attention to an alternative institutional form of environmental regulation, the voluntary environmental programs (VEPs). Unlike conventional government-led regulation, VEPs offer businesses the flexibility to adopt cost-effective measures to reduce their environmental impact (Coglianese & Nash, 2016; Lim & Prakash, 2014; Prakash & Potoski, 2012). Rather than enforcing firms to act through regulatory threats, VEPs aim to motivate firms to move forward by offering various kinds of positive incentives, ranging from public recognition to limited forms of regulatory relief (Berliner & Prakash, 2013; Darnall & Carmin, 2005; Darnall & Sides, 2008; Prakash & Potoski, 2012).

Despite VEPs' theoretical appeal and practical proliferation, scholars have also indicated potential problems with the VEP mechanism. Concerns over the voluntary nature of VEPs drive questions surrounding participation motivations and program effectiveness. First, given the voluntary nature of VEPs, it is unclear whether these programs are providing environmental protection, or they are just "greenwashing" that participating firms simply signal environmental commitment without actually improving their environmental performance (M. A. Delmas & Montes-Sancho, 2011; King et al., 2005; Li et al., 2020; Zhou et al., 2019). Some even worry that VEPs can be a tool for the government to shirk its responsibilities (Coglianese & Nash, 2016; M. Delmas & Keller, 2005). Accordingly, the empirical literature finds mixed evidence of the impact of VEPs on environmental outcomes, and it is not clear as to what types of voluntary programs can yield an incremental improvement in performance. Second, it should be noted that the number of participating firms in a VEP is usually limited, which limits the societal effects VEPs can have. Then, if VEPs are environmentally effective, under what conditions will VEPs be able to achieve expansion and produce more influential environmental impacts? In recent years, some local and state governments have made attempts to integrate private VEPs into their public mandatory codes. Then what will happen if the voluntary programs are converted to be mandatory? Whether this new alliance is able to create more formal change in favor of sustainability transitions? In sum, little is known about the actual relationship between various program design elements and the VEP effects, and even less is known about the mechanisms to expand the impact of VEPs and enlarge their alleged benefits.

To solve these puzzles, my dissertation introduces the institutional lens to understand the motivations and the mechanisms that govern the behavior of individuals in this context. In the first chapter, I systematically reviewed two decades of literature to perform a quantitative meta-analysis about the impact of institutional design choices on the efficacy of VEPs. I extracted the point estimates of VEP outcomes in the empirical literature and identified such design elements of the VEPs in sampled studies as monitoring regime, information disclosure, educative assistance, and sponsorship. I then examined the aggregate relationship between VEP participation and environmental outcome, and how this relationship differs between different

dimensions of the program design elements. The two basic types of VEP mechanism - signaling and performance benefits – were examined. With the empirical results, I demonstrated the effectiveness of VEPs in environmental stewardship together with the prominent role of institutional design choices in explaining why some VEPs achieve large environmental outcomes while others fail. This chapter shows that institutional design elements matter to the environmental efficacy of VEPs. In particular, strong institutional design works well in promoting private sustainable practices. However, in the meantime, weak designs can also work. This indicates that firms may not only react to signaling effects; instead, intrinsic motivations or performance benefits could also play a role.

In my second chapter, I looked at the global dissemination of a private environmental governance regime for green buildings, the LEED (Leadership in Energy and Environmental Design) certification. This work notes that, in addition to the firm level factors often examined by the VEP literature, country-level determinants such as the public regulatory setting and the level of economic development also shape firms' calculated decisions to seek certification under the private building standard. Using a panel of 148 countries from 2007 to 2018, it challenges the argument that economic development is an unconditional driver of green building expansion and highlights how builders use the private LEED certification to signal their environmental stewardship especially when the image of their public regulatory settings is disadvantageous in market. Specifically, I find that domestic environmental regulation can impact firms' decisions of pursuing private regime. Domestic institutions have strong effects on private decision-making of joining private regimes. Conditional on income level, regulatory climate has different effects on the development of private environmental regimes.

Third, I continued the tread of the LEED case and explored the changing relationship between public mandates and private adoptions of this green building standard. This coincides with the recent theme of policy feedback studies devoted to understanding how existing policy legacies shape subsequent policy changes. Using a panel data from a set of states across the U.S., I compared lobbying registration records of states before and after the policy adoption of LEED with the records of a set of states that did not make such change over the same time period. Since most quantitative studies of policy feedback theory comes from the analysis of policy effects on mass publics and political participation, my measure of interest group mobilization adds methodological contribution to the feedback literature and informs those interested in seeking quantitative evidence of the policy feedback theory. Moreover, the results show that policy adoptions of the private voluntary program, LEED, can impact the level of interest group involvement in lobbying activities. Yet, this impact varies depending on the contextual and design elements of the adopted policy. From the examination of post-policy political activities, this chapter shows that positive feedback is not the only form of historical institution. Since the environmental policy literature often neglected the role of policy feedback in environmental policy processes, this paper is also expected to provide implications for feedback studies in the area of environmental policy studies, and adds to the growing understanding of local governments as innovators in aspects of environmental governance that are beyond the scope of the tradition government-led command-and-control instruments.

Beyond these findings, this dissertation also poses some future directions of research for my own academic career and hopefully the broader literature. First, more attention could be paid to the design of VEPs. First, as we have discussed, what is true effect of public disclosure? As a

heated policy instrument in environmental regulation, it is worth investigating under what conditions would public disclosure work to promote environmental behaviors. In addition, more research on program design will help us get a better understanding of how to use different design elements to correct practical problems such as inadequate funding and insufficient public trust. Second, from my analysis, private regimes usually would not develop at the same level as more developed countries. However, with a better established public regulation setting, the increase in the level of private regimes' development could be higher in developing than developed countries. So, what are the explanations for this? If firms are signaling their environmental stewardship to different actors in developed and developing countries, why does this happen? Maybe some other measures of regulation such as regulatory discretion and administrative corruption can help. Also, I would consider if there were heterogeneity across industries, which might also explain why some countries tend to show more VEP adoptions. Third, the interaction between public and private regimes needs more theoretical and empirical development. What is the dividing line between voluntary and mandatory regulations? How to consider the synergy effects of public and private regulation is worth investigating.

Altogether, this dissertation project informs knowledge associated with two enduring puzzles of environmental policies: the first relates to ascertaining the effectiveness of associated political instruments such as directives, disclosure, and certifications, and the second centers on whether non-regulatory approaches produce meaningful results or merely reflect more sophisticated forms of capture. This dissertation demonstrates the efficacy of VEPs in promoting environmental protection and introduces the lens of institutions to explain the conditions under which VEPs are more likely to produce practical results. Given the growing need for environmental protection and the shortage of available resources to meet the need, such insights can help policymakers better understand the appropriateness and efficacy of different policy instruments in managing the environment, and add to the growing understanding of private actors as innovators in aspects of environmental governance that are beyond the scope of the tradition government-led command-and-control instruments. Therefore, society can make better informed public and private decisions surrounding a variety of mechanisms to produce social welfare benefits with low social costs in the environmental realm.

Appendices

Appendix A: Chapter 2 Supplementary Materials

A1: Analytic Strategies of RVE

Mean effect sizes and meta-regression models using RVE were estimated using a weighted least squares approach (see (Tanner-Smith, Tipton, and Polanin 2016; Tipton and Pustejovsky 2015) for more information). In the RVE framework, a simple model that relates the effect sizes T to a set of covariates in a design matrix X and a vector of regression coefficients β can be written:

$$T = \mathrm{X}\beta + \varepsilon,$$

where ε is a vector of residuals. For example, for effect size i in study j, this model can be written as follows:

$$T_{ij} = \beta_1 X_{1ij} + \beta_2 X_{2ij} + \cdots + \beta_p X_{pij} + \epsilon_{ij},$$

where the effect size T_{ij} may be explained to some degree by p covariates $\mathrm{X}_{1ij} \ldots X_{pij}$. The wegithed least-squares estimate of $\beta = (\beta_1, \ldots \beta_p)$ can be calculated using

$$\mathfrak{b} = (\mathrm{X}'W\mathrm{X})^{-1}(\mathrm{X}'\mathrm{WT}),$$

where W is a matrix of weights. In the RVE framework, the variance of the estimate of b of beta can be written as

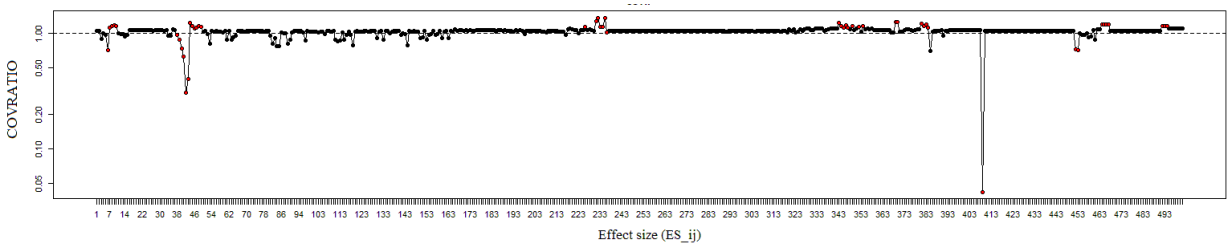
$$V^R(\mathfrak{b}) = \left(\sum_{j=1}^{m} \mathrm{X}'_j W_j \mathrm{X}_j\right)^{-1} \left(\sum_{j=1}^{m} \mathrm{X}'_j W_j \mathrm{e}_j \mathrm{e}'_j \mathrm{W}_j \mathrm{X}_j\right) \left(\sum_{j=1}^{m} \mathrm{X}'_j W_j \mathrm{X}_j\right)^{-1},$$

Where for study j, X_j is the design matrix, W_j is the weight matrix, and $\mathrm{e}_j = T_j - X_j b$ is the estimated residual vector for study j. The random effects inverse variances weights used for the RVE analysis were calculated as

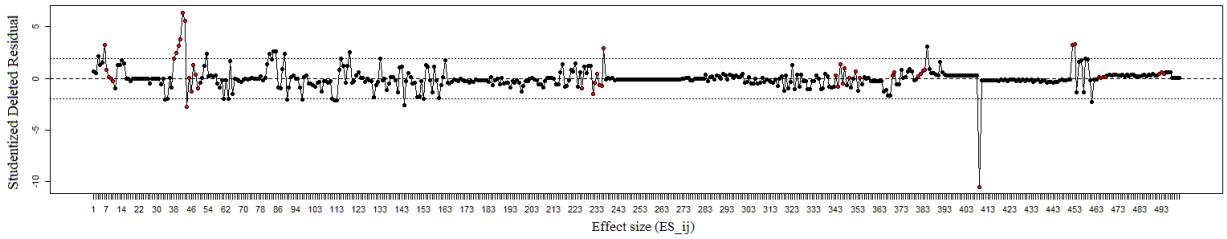
$$W_{ij} = \frac{1}{\left(V_j + \tau^2\right)\left(1 + \left(k_j - 1\right)\right)},$$

Where V_j is the mean of the within-study sampling variance for each study j, $\tau^2$is the estimate of the between-studies variance component, and k_j is the number of effect sizes within each study j.

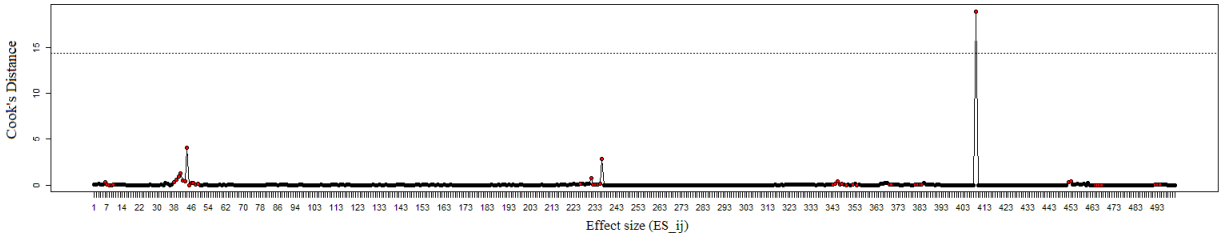
A2. Supplemental Figures of Outlier and Influence Diagnostics



(a) studentized deleted residuals



(b) Cook's distances



(c) COVRATIO values

Figure A1 Diagnostic plots for the 502 effect sizes

Appendix B: Chapter 4 Supplementary Materials

B1: Map of Municipal-level LEED policies

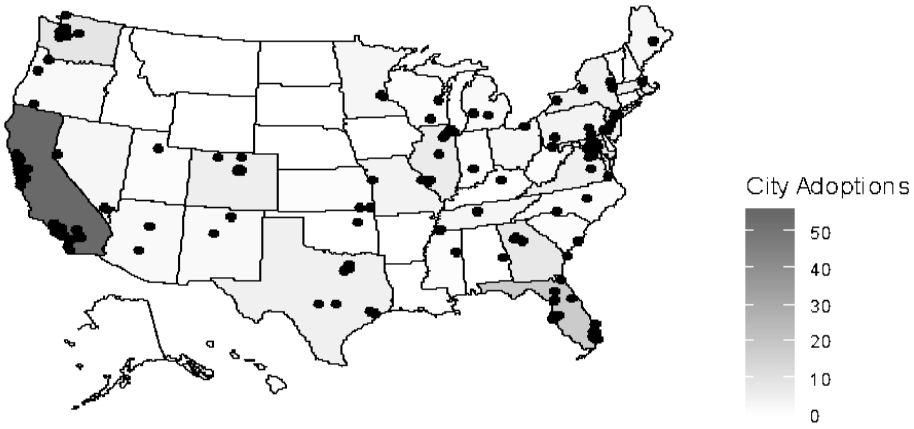


Figure A2 Municipal adoption of LEED policies in the US, by 2019

(Data source: USGBC)

B2: State-level LEED Policy Adoptions in the US

Compiled from USGBC Public Policy Library.

1. AR 2005

US-AR-2005-HB 2445: On February 25, 2005, Governor Huckabee signed HB 2445, the "Arkansas Energy and Natural Resources Conservation Act," encouraging all state agencies to use green design strategies, including LEED and Green Globes. The bill also creates the Office of Sustainability with the Arkansas Department of Environmental Quality and the Legislative Task Force on Sustainable Building Design and Practices which is to meet and continue to review, discuss and advise on issues related to sustainable building design.

2. AZ 2005-2013

US-AZ-2005-Executive Order 2005-05: On February 11, 2005, Governor Janet Napolitano signed Executive Order #2005-05 requiring all state-funded buildings to achieve LEED Silver certification. The Executive Order also requires newly constructed state-funded buildings to incorporate renewable energy. This makes the state the first governmental entity in Arizona to adopt a mandatory green building standard.

US-AZ-2013-Chapter 9 House Bill 2009: On June 17, 2013, the State of Arizona adopted Chapter 9, House Bill 2009, granting tax relief to datacenters that move into substantially vacant buildings and certify under the LEED Green Building Rating System, or an equivalent standard, for the deduction of the gross proceeds of sale or gross income from the sale of qualified equipment.

3. CA 2011-2012-2013

US-CA-2011-Chapter 354: On February 17, 2011, the State of California enacted Chapter 354 authorizing the Governor to designate a project that is certified LEED silver or higher, that has a 10% greater standard for transportation efficiency than for comparable projects and is located on an infill site as a leadership project for streamlining through the Environmental Impact Report pursuant to the California Environmental Quality Act.

US-CA-2012-Executive Order B-18-12: On April 25, 2012, Governor Brown of California signed Executive Order B-18-12 creating the Green Building Action Plan. The implementation plan requires all new and majorly renovated State buildings larger than 10,000 sq. ft. to obtain LEED Silver or higher using the applicable version of LEED. Additionally, all existing State buildings over 50,000 sq. ft. are required to complete LEED – EB certification by December 2015, if cost effective.

US-CA-2013-California Code of Regulations Title 4, Division 17, Chapter 1: On March 29, 2013, the state of California adopted Reg. CA 134993, establishing regulations regarding the allocation of the federal and state low-income housing credit. The state tax credit allocation committee awards points to projects, determining which projects would receive prioritization. Projects that achieve LEED certification at the Silver or Gold level, or are certified under the

GreenPoint or Enterprise Green Communities standards, are eligible to receive additional points to contribute to the project's overall score. Additional points can also be awarded for the inclusion of solar photovoltaic panels and building systems commissioning practices.

4. CO 2005-2007-2018

US-CO-2005-Executive Order D005 05: On July 15, 2005, Governor Owens signed Executive Order # D005 05 adopting LEED for Existing Buildings and incorporating LEED for New Construction practices for all state buildings. The order also creates a Colorado Greening Government Coordinating Council to develop and implement conservation policies.

US-CO-2007-SB 07-051: In September of 2007, the State of Colorado passed SB 07-051 and created the High-Performance Certification Program. The policy, last updated in 2018, requires new or majorly renovated state-owned buildings, K-12 schools, public universities, and housing projects over 5,000 sq. ft. and receiving a minimum of 25% of funding from the state to achieve LEED Gold certification.

US-CO-2007-Senate Bill 51: On April 16, 2007, Governor Bill Ritter signed Senate Bill 51 into law requiring any new or renovated building whose total project cost includes 25 percent or more in state funds to be designed and built to a high performance green building standard. The new law requires the State Architect to select an independent third-party certification program, such as LEED. The project must achieve the highest level performance certification possible, which is determined by calculating whether the increased initial costs can be recouped from decreased operational costs within 15 years.

US-CO-2018 (update 07-SB 07-051): In September of 2007, the State of Colorado passed SB 07-051 and created the High-Performance Certification Program. The policy, last updated in 2018, requires new or majorly renovated state-owned buildings, K-12 schools, public universities, and housing projects over 5,000 sq. ft. and receiving a minimum of 25% of funding from the state to achieve LEED Gold certification.

5. CT 2011-2013

US-CT-2011-Public Act No. 11-57: On June 30, 2011, the State of Connecticut adopted Public Act No. 11-57, authorizing proceeds from state issued bonds to be used by Connecticut's Department of Energy and Environmental Protection for the purpose of funding the net project costs, or the balance of any projects after applying any public or private financial incentives available, for any renewable energy or combined heat and power projects in state buildings. The funds shall be made available through the Renewable Energy Investment Fund, established pursuant to section 16-245n. Eligible state buildings shall be Leadership in Energy and Environmental Design (LEED) certified or in the process of becoming LEED certified or in the process of becoming LEED silver rating certified or receive a two-globe rating in the green Globes USA design program or in the process of receiving a two-globe rating in the Green Globes USA design program.

US-CT-2013-Public Act No. 13-308: On July 12, 2013, the State of Connecticut adopted Public Act No. 13-308, granting development fee reductions or waivers to projects that certify with the

LEED green building rating system at the gold level, or higher, on brownfield sites. Fee waivers will be awarded for projects moving into distressed communities.

6. DE 2010

US-DE-2010-Executive Order 18: On February 17, 2010, the Governor of Delaware signed Executive Order 18: LEADING BY EXAMPLE TOWARDS A CLEAN ENERGY ECONOMY & SUSTAINABLE NATURAL ENVIRONMENT. The order states that all state agencies, departments and offices shall work with architects and engineers working on the design and construction of capital projects to design projects to meet or exceed LEED Silver standards. Additionally, the order includes energy performance reduction targets by stating that all state executive branch agencies, departments and offices shall achieve an overall collective reduction, from fiscal year 2008 levels, in energy consumption of at least 10% by the end of fiscal year 2011, 20% by the end of fiscal year 2013, and 30% by the end of fiscal year 2015.

7. FL 2007-2008-2013-2014

US-FL-2007-Executive Order 07-126: On July 13, 2007, Governor Crist issued Executive Order #07-126 requiring LEED-NC certification for any new building constructed for or by the State. New construction projects must strive for Platinum certification, the highest level possible. The Executive Order also requires the Department of Management Services to implement LEED-EB across all buildings currently owned and operated by the department on behalf of client agencies. In addition, agencies and departments are instructed to only enter into new leasing agreements for office space that meets Energy Star building standards, unless no other viable alternative exists.

US-FL-2008-HB 7135: On June 25, 2008, Governor Crist signed into law HB 7135, requiring all new construction and renovation of state-owned and state-funded buildings to follow the guidelines of LEED or other green building rating systems, including Green Globes and the Florida Green Building Coalition standards. The bill requires the same of the following public entities in the State of Florida entering design after July 1, 2008: counties, municipalities, school districts, water management districts, state universities, community colleges, and Florida state courts. The bill further requires that all new leases of state-occupied office space must meet Energy Star.

US-FL-2013-Chapter No. 2013-193: On June 17, 2013, the State of Florida enacted Chapter 2013-193, requiring each state agency to use a sustainable building rating system or national model green building code for each new building and renovation to existing buildings. Additionally, the policy mandates that a representative of the green building industry, such as an individual accredited under LEED or a Florida board member of the U.S. Green Building Council, shall be appointed to the Florida Building Commission.

US-FL-2014-Public Property and Publicly Owned Buildings: Chapter 255 (Public Property and Publicly Owned Buildings) of the 2014 Florida Statutes requires all buildings constructed and financed by the state and renovations of existing state facilities to be designed to comply with a sustainable building rating or a national model green building code. A sustainable building rating or national model green building code is defined as either LEED, IGCC, Green Globes, Florida

Green Building Coalition standards or other nationally recognized, high-performance green building rating system, as approved by the department.

8. HI 2006

US-HI-2006-HB 2175: On June 26, 2006, Governor Lingle signed HB 2175 requiring each state agency to design and construct buildings to achieve LEED Silver certification, two Green Globes or equivalent. The law applies to all new state-owned or state-funded construction of 5,000 square feet or greater, including K-12 public schools. The Hawaii state legislature amended its provisions to Hawaiian counties with another resolution (HRS 46 19.6), requiring priority processing for all construction or development permits for projects that achieve LEED Silver, two Green Globes or equivalent.

9. IA 2009

US-IA-2009-Chapter 310: On January 1, 2009, the Iowa State Legislature adopted sustainable design standards codified in Chapter 310 of the State Code. Commercial buildings pursuing sustainable design standards in order to qualify for a tax credit or tax refund must achieve LEED Gold certification or better. If a commercial project pursues sustainable design standards for a purpose other than to qualify for a tax credit or refund, the building must attain at least LEED Silver certification. Construction of buildings intended to be used as data centers must achieve LEED Certification in order to qualify as a sustainably designed development.

10. IL 2009

US-IL--2009-HB 1013: On July 24, 2009, Governor Quinn signed into law HB 1013, requiring all new state-funded building construction and major renovation of existing state-owned facilities to seek LEED or equivalent certification. New buildings and major renovations of 10,000 square feet or more must achieve at minimum LEED Silver or equivalent certification. New buildings and major renovations under 10,000 square feet must strive to meet the highest standard of the LEED rating system or equivalent but are not required to achieve certification.

US-IL-2009 Green Buildings Act: On July 24, 2009 the Green Buildings Act was passed into law by the Illinois General Assembly. The law requires all new state-funded construction and major renovations less than 10,000 square feet to met the highest standard of LEED, or an equivalent standard. All new state-funded construction and major renovations of or larger than 10,000 square feet must achieve LEED Silver certification, or an equivalent.

US-IL--2009-Public Act 96-0630: On August 24, 2009 Illinois Governor Quinn signed SB 1601, enacting Public Act 96-0630.The act, to take effect in January 2010, addresses several components of building design to improve sustainability through renovation projects. LEED and Green Globes certification costs have been added as valid "Redevelopment Project Costs" that can be funded by the Illinois Tax Increment Fund.

US-IL-2009-House Joint Resolution 10: On April 22, 2009 the Illinois General Assembly adopted House Joint Resolution 10 stating that the passage of a sustainable capital construction plan ought to be a top priority. The resolution also states that any allocations of funding for the

construction or renovation of government buildings should require builders to adhere to LEED or equivalent green building standards.

11. IN 2008

US-IN-2008-Executive Order 08-14:On June 28, 2008, Governor Daniels signed Executive Order 08-14, requiring all new state buildings to earn LEED Silver certification, the EPA's Energy Star rating, two Globes under the Green Globes rating system, or the equivalent under an ANSI accredited rating system. The EO also requires that all renovations of existing state buildings must follow LEED, Green Globes, or other guidelines.

12. KY 2007-2008

US-KY-2007-HB 1: On August 30, 2007, Kentucky Governor Fletcher signed HB1 into law, a bill that included an addition to KRS 56.776 that would instruct the Finance and Administration Cabinet to use LEED or other rating systems to develop green building incentives for private development in the Commonwealth of Kentucky.

US-KY-2008-HB2: On April 24, 2008, Governor Beshear signed HB 2, requiring all new public facilities and renovations using 50% or more of state High Performance Building Standards. High Performance Building Standards can be met as follows: projects of $25 million or more must achieve LEED Silver certification or higher; projects between $5 million and $25 million must achieve LEED Certified and earn a minimum of seven points under the Energy and Atmosphere Credit 1, Optimize Energy Performance standards; and, projects between $600,000 and $5 million shall use the LEED rating system as a guide.

13. MA 2007

US-MA-2007-Executive Order 484: On April 18, 2007, Governor Deval Patrick signed Executive Order 484, "Leading by Example - Clean Energy and Efficient Buildings." The order instructed all agencies involved in the construction and major renovation projects of over 20,000 square feet to meet LEED certification, incorporating energy performance 20% better than the Massachusetts Energy Code and outdoor water reduction requirements verified by an independent 3rd party commissioning authority.

14. MD 2001-2007-2011-2014

US-MD-2001-Executive Order 01.01.2001.02: On March 13, 2001, the Governor signed Executive Order 01.01.2001.02, mandating the development of a High Efficiency Green Building Program. The Executive Order charged the Council with creating the High Efficiency Green Buildings Program and with making recommendations to the Governor regarding appropriate criteria, standards and a numeric rating system (modeled after LEED Green Building Rating System and the federal Energy Star Program) for use by the Program.

US-MD-2007-HB 942: On April 24, 2007, House Bill 942 re-established the Maryland Green Building Council in the Department of General Services and established the State’s High Performance Green Building Program. HPGBA applies to all capital projects, including K-12 schools and community colleges, funded solely with state funds. New construction and major

renovation of buildings 7.500 sq. ft. or greater must achieve at minimum LEED Silver – and wherever possible strive for LEED Gold. The Council also outlines mandatory credits state projects must achieve under the HPGBA. In 2017, the Council after studying the effects of LEED v4 on the Council's mandatory credits, updated the High Performance Green Building Program to better accommodate LEED v4.

US-MD-2011-Chapter 9: The State of Maryland's Property Tax Code Chapter 9-242 permits local governments to offer a tax credit against the county or municipal corporation property tax imposed on a high performance building. A high performing building includes buildings that achieve LEED Silver certification or higher.

US-MD-2014-Chapter 601: On May 15, 2014, Maryland adopted Chapter 601, extending the Sustainable Communities Tax Credit Program which for commercial rehabilitation, establishes a competitive award process for credit certifications for Maryland sustainable communities tax credits that favors high performance buildings that meet or exceed LEED gold certification, and provide a tax credit for the rehabilitation of small commercial properties under specified circumstances.

14. ME 2003-2011

US-ME-2003-Energy Conservation in Buildings Act: On November 1, 2003, Maine Governor John Baldacci issued an Executive Order directing all new or existing state buildings to incorporate LEED guidelines, including LEED for Existing Buildings: Operations and Maintenance, provided that standards can be met on a cost-effective basis..

US-ME-2003-Energy Conservation in Buildings Act was repealed by Governor LePage on December 7, 2011

15. MN 2007

US-MN-2007-CHAPTER 136 S.F.No. 145: On May 25, 2007, the Governor of Minnesota enacted Chapter 136 S.F.No. 145, establishing the Next Generation Energy Act of 2007, an act relating to energy efficiency and conservation. The act requires utilities to establish programs that facilitate professional engineering certification to qualify buildings as ENERGY-STAR labeled, LEED certified, or Green Globes-certified. The state goal was to achieve 1,000 ENERGY-STAR labeled commercial buildings and 100 LEED or Green Globes-certified commercial buildings by December 31, 2010.

16. MT 2019

US-MT-2019-High Performance Building Standards: In March of 2019, the State of Montana revised its High-Performance Building Standards. The High-Performance Building Standards required all state projects funded or authorized by the Legislature greater than $10,000,00 to achieve LEED Silver certification or a Green Globes Rating of a minimum Two Globes rating. The revision also updates LEED requirements to LEED v4.

16. NC 2007

US-NC-2007-Senate Bill 581: On August 2, 2007, the State of North Carolina adopted Senate Bill 581 into law, allowing counties and cities to provide building permit fee reductions or partial rebates to encourage construction of buildings using sustainable design principles such as LEED, Green Globes or an equivalent certification system.

17. NJ 2008-2013-2016

US-NJ-2008-Chapter 269: On January 13, 2008, the State of New Jersey passed Chapter 269, requiring any new state building over 15,000 square feet to be designed to meet the standards of a "high performance building." A "high performance building" is defined by the policy as a building that receives at least a LEED Silver certification, two Green Globes or a comparable rating from a nationally recognized and accepted rating system that has been approved by the Commissioner of Community affairs in consultation with the Commissioner of Environmental Protection, the Director of Energy Savings and the Board of Public Utilities.

US-NJ-2013-AB 3680: On September 19, 2013, the state of New Jersey enacted Assembly Bill 3680, requiring all construction projects to be submitted to the New Jersey Economic Development Authority and be encouraged to adhere to the LEED rating system.

US-NJ-2013-AB 3680 was updated in 2016: Commercial buildings must comply with LEED silver requirements to achieve standards.

18. NM 2007-2009-2013-2015

US-NM-2007-SB 543: In April 2007, Governor Bill Richardson signed SB543 into law. The omnibus bill included a sustainable building tax credit to promote the construction of high performance, green design and construction. The credit applies to LEED for New Construction, Silver and higher; LEED for Existing Buildings, Silver or higher; LEED for Core and Shell, Silver and higher; LEED for Commercial Interiors, Silver or higher; and LEED for Homes, Silver or higher. The credit increases commensurate with the level of LEED certification achieved. The total amount of tax credits shall not exceed an aggregate amount of $5 million with respect to commercial buildings and an aggregate amount of $5 million with respect to residential buildings.

US-NM-2009-SB 291: On April 1, 2009, Governor Richardson signed SB 291, the Sustainable Building Tax Credit. This legislation provides tax credits based on the square footage of the building. For commercial buildings, the tax credits range from $3.50 per square feet for buildings that achieve LEED for New Construction Silver certification to $6.25 per square feet for buildings that achieve LEED for New Construction Platinum certification. For residential buildings, the tax credits range from $5.00 per square feet for buildings that achieve LEED for Homes Silver certification to $9.00 per square feet for buildings that achieve LEED for Homes Platinum certification.

US-NM-2013-SB 14: On March 16, 2013, the state of New Mexico adopted Senate Bill 14, renewing the Sustainable Building Tax Credit, thereby creating an additional $12 million opportunity for single-family residential green construction and $3 million in commercial and

multifamily opportunities spread out over the next three years. Commercial buildings which have been registered and certified by the US Green Building Council at LEED Silver or higher for new construction (NC), existing buildings (EB), core and shell (CS), or commercial interiors (CI) are eligible for a tax credit. The amount of the credit varies according to the square footage of the building and the level of certification achieved.

US-NM-2015-SB 279: On April 10, 2015 the state of New Mexico adopted Senate Bill 279, updating the Sustainable Building Tax Credit. The new SBTC guideline establishes a personal tax credit and a corporate tax credit for new and major renovations that are certified to LEED Silver or higher for taxable years up to 2026. The tax credit amount is based on certification level achieved and the amount of qualified square footage. The tax credit is available for commercial and residential buildings under LEED - NC, LEED EB and LEED CI and LEED for Homes. The 2015 update caps the eligible size per residential project at 2,000 sq. ft. and reduces the amount of the tax credit available per square foot.

19. NV 2005-2007-2013

US-NV-2005-AB 3: On June 17, 2005 the State of Nevada passed Assembly Bill 3, requiring all state funded buildings be LEED Certified or higher in accordance with LEED or an equivalent standard. During each biennium, at least two occupied public buildings whose construction will be sponsored or financed by the State of Nevada must be designated as a demonstration project and be equivalent to a LEED Silver or higher certification, or an equivalent standard. The bill also provides tax abatements for property which has an eligible LEED Silver building and tax exemptions for products or materials used in the construction of a LEED Silver building.

US-NV-2007-AB 621: On June 15, 2007 the State of Nevada passed AB621, amending previous green building tax abatement legislation passed in June 2005. The Bill amends provisions of tax abatements and exemptions based upon the use of energy and repeals certain prospective energy requirements for public buildings. Companies that had planned construction projects by December of 2005 and received State approval by February 2007 will not be affected by the change. AB621 creates a three tiered property tax exemption plan, with a maximum exemption of 35% for any private building achieving LEED certification at the Silver level or higher, excluding single-family homes and residential structures three stories or fewer. In addition, the legislation removes sales tax exemptions for products or materials used in the construction of eligible buildings.

US-NV-2013-AB 239: On June 11, 2013, the state of Nevada adopted Assembly Bill 239, reviving the tax incentive for LEED-certified buildings and expanding its scope to investments in improving existing buildings, wherein LEED-certified projects receive up to a 35% reduction on property tax payable for 5-10 years for new buildings. Renovations to existing buildings that achieve LEED certification receive a 25-35%, based on level of certification, property tax abatement for 1 year.

20. NY 2007-2008-2011-2012-2013

US-NY-2007-New York State Green Building Plan: On August 28, 2007, the Dormitory Authority, an agency that provides construction, financing and allied services which serve the

public good of New York State, announced its commitment to register all new construction and major renovations projects with USGBC beginning in 2008, with a goal of achieving LEED Silver certification.

US-NY-2007-New York State Green Building Tax Credit Program: In 2007, the New York State Green Building Tax Credit Program was created to provide an income tax incentive to commercial developments incorporating specific green strategies informed by LEED. As of 2011, individuals or businesses can no longer earn a new green building credit. However, they may claim a green building credit carryover from previous years.

US-NY-2008-A10684: On April 28,2008, Governor Patterson signed A10684, authorizing the New York Star Energy Research and Development Authority (NYSERDA) to create and administer a green residential building grant program to encourage the construction of new homes and the renovation of existing homes that follow green building standards and criteria based on LEED for Homes. NYSERDA is authorized to provide incentives to qualified owners between January 1, 2010 and October 31, 2013.

US-NY-2011-Chapter 129: On July 18, 2012, the state of New York enacted Chapter 129, requiring residential property achieving LEED certification to be exempt from capital improvements to residential buildings in cities with a population between 27,500 and 28,000 for 3 (certified/silver) years to the extent of 100% of the increase in assessed property value attributable to such reconstruction. Gold certified structures have a 4 year exemption, and Platinum certified have 6 years.

US-NY-2012-Chapter 188: On July 18, 2012, the state of New York enacted Chapter 188, authorizing municipalities to waive property taxes for green buildings and provides exemptions for construction improvements that meet LEED certification standards.

US-NY-2013-Chapter 14: On March 15, 2013, the state of New York enacted Chapter 14, authorizing municipalities to waive property taxes for green homes and commercial buildings. Cities and towns adopting the new measure will take LEED certified properties off their tax rolls for up to six years, tax exemptions are based on certification level and phase out over a period of 7-10 years.

US-NY-2013-Chapter 174: On June 18, 2013, the state of New York enacted Chapter 174, stating that the decision by the state gaming board to select a to select a gaming facilities license applicant shall be weighed by 10% based on workforce enhancement factors including, the construction or renovation of gaming facilities to be certified under the appropriate LEED rating system.

US-NY-2013-Chapter 441: On October 23, 2013, the state of New York enacted Chapter 441, establishing a tax exemption in cities with a population of not less than 130,000 and not more than 160,000 for rehabilitation of vacant residential structures or construction of new qualified residential structures that certify under the appropriate LEED rating system.

21. OK 2008

US-OK-2008-HB 3394: On June 3, 2008, Governor Henry signed HB 3394 into law, requiring all state buildings over 10,000 square feet to follow LEED guidelines. Compliance will be measured by the Department of Central Services. The Department of Central Services shall identify and seek to have any public building that has been designed, constructed, or renovated in accordance with the standards of the high-performance certification program designated as an ENERGY STAR building by the United States Environmental Protection Agency. This legislation applies to buildings entering the design phase after July 1, 2008.

22. OR 2011-2012

US-OR-2011-Chapter 730: On August 5, 2011, Oregon enacted Chapter 730, establishing the Renewable Energy Development Sub-account. In order for a tax credit to be allowable, the project must meet LEED Platinum certification, a 4 Green Globes rating, or a nationally or regionally recognized and appropriate sustainable building program whose performance standards are equivalent.

US-OR-2012-Oregon Administrative Rules, Chapter 330, Division 90: On January 13, 2012, the State of Oregon adopted Oregon Administrative Rules, Chapter 330, Division 90, establishing a Business Energy Tax Credit (BETC) for up to 35% of the eligible cost of qualifying renewable energy resource facilities. The Oregon Department of Energy may issue only one BETC for each separate and distinct facility. The following facilities are eligible for a BETC: an energy saving facility, recycling facility, rental dwelling weatherization facility, transportation facility, car sharing facility, sustainable building practices facility, alternative fuel vehicle or facilities necessary to operate alternative fuel vehicles, including but not limited to an alternative fuel vehicle refueling station, a high-efficiency combined heat and power facility, a high-performance home, a homebuilder-installed renewable energy system or a research development and demonstration facility that complies with the rules in place. A Sustainable Building Practices Facility means a a building that is rated and certified LEED-NC, LEED-CS, or LEED-CI under the LEED Green Building Rating System managed by the U.S. Green Building Council or is rated and certified by a program approved by the Oregon Department of Energy. In addition to achieving LEED certification a "Sustainable Building Practices Facility" must also earn at least two points Under LEED Energy and Atmosphere Credit 1 (Optimize Energy Performance) and at least one point under LEED Energy and Atmosphere Credit 3 (Enhanced Commissioning) in order to receive a Business Energy Tax Credit.

23. PA 2019

US-PA-2019-Executive Order 2019-01: On January 8th, 2019, the Governor of Pennsylvania issued Executive Order 2019-01, which re-establishes the Governor's Green Government Council. Executive Order 2019-01 also requires all agencies to reduce energy consumption, requires renewable energy to offset at least 40% of Commonwealth energy use, and encourages LEED certification.

24. PR 2007

US-PR-2007-Executive Order OE-2007-41: On October 24, 2007, Governor Acevedo Vila signed Executive Order OE-2007-41, requiring that all new construction or major renovations of government-owned or substantially-funded buildings earn LEED certification, including buildings built for the use of the Commonwealth, including schools. Applicable buildings of 10,000 square feet or greater are required to earn LEED Certified, and 30,000 square feet or greater to earn LEED Silver certification. The EO further requires all such buildings to certify at least every 5 years through LEED for Existing Buildings, or the most appropriate USGBC-sponsored rating system. The certification thresholds for existing buildings are also LEED Certified for 10,000 square feet or greater, and LEED Silver for 30,000 square feet or greater.

25. RI 2005-2015-2017

US-RI-2005-Executive Order 05-14: On August 22, 2005, Governor Carcieri signed Executive Order 05-14 requiring all new construction and renovations of public buildings to be designed and constructed to at least LEED certified, or an equivalent high performance green building standard. All major facility projects of public school districts are also required to be designed and constructed to at least the LEED certified standard, or to the standards of the Northeast Collaborative for High-Performance Schools Protocol Version 1.1.

US-RI-2015-Executive Order 15-17: On December 8, 2015, Governor Raimondo signed Executive Order 15-17, which establishes the Lead By Example Program within Rhode Island's Office of Energy Resources. The order calls for state agencies to reduce the use of natural resources at all facilities, switch to 100% renewable energy by 2050, and publicly post energy use. Executive Order 15-17 also directs the Division of Capital Asset Management and Maintenance to develop a high standard of building operations and maintenance, which may be achieved through LEED certification.

US-RI-2017-Chapter 37-24 The Green Buildings Act: On November 9, 2009, Governor Carcieri signed the Rhode Island Green Building Act into law. The Act requires all major facility projects of public agencies entering the design phase after January 1, 2010, to achieve LEED Certified or equivalent. It also requires all major facility projects of public school districts where the project receives funding from the state entering the design phase after January 1, 2010, to achieve LEED Certified or the Northeast Collaborative for High-Performance Schools Protocol. In October 2017 Governor Gina Raimondo signed 0952A/H-5427A into law, amending the state's Green Buildings Act to include LEED for Neighborhood Development (LEED-ND) and the Sustainable SITES Initiative (SITES) as applicable standards for the sustainable development of real public property beyond the physical buildings themselves.

26. SC 2007

US-SC-2007-H3034: On June 20, 2007, the South Carolina legislature passed H3034 establishing the South Carolina Energy Efficiency Act. The law requires all state-funded new construction building projects, including K-12 schools, in which the building is larger than 10,000 sq. ft. or renovation project in which the project involved more than 50% of the replacement value major to be designed, constructed, and at least certified as LEED Silver standard (or as receiving two globes using the Green Globes Rating System). Agencies are

required to use the most current edition of the rating system available at the time of registration and earn at least 40% of the available points under the Optimize Energy Performance credit.

27. SD 2008

US-SD-2008-SB 188: On March 17, 2008, South Dakota Governor Rounds signed into law SB 188, establishing leadership in public buildings by requiring all new construction and major renovations of state-owned buildings costing at least $500K or greater than 5,000 square feet to earn LEED Silver, two Green Globes or a comparable standard. Twice, new bills were passed during the legislative session that updated the requirements to the newest standard of LEED. Most recently, HB 1029 in 2015 updated the standard to LEED v4 and increased the threshold for compliance to 1 million dollars or more and 10,000 sq. ft. or greater.

28. TN 2009

US-TN-2009-SB 1919: On June 23, 2009, Governor Bredesen signed into law SB 1919, revising statutes governing housing authorities to expand opportunities for redevelopment. The revised statute permits housing authorities to finance additional investments in green building and energy efficiency, and specifically any costs related to modeling, documentation and certification fees for LEED, Green Globes or other related expenses.

29. UT 2009

US-UT-2009-High Performance Building Rating System: On May 21, 2009, the Utah State Building Board raised the High Performance Building Rating System standards to require all new state buildings achieve LEED certification at the Silver level. Specifically, new building projects must achieve the following credits: WE Credit 1.1, EA Credit 3, EQ Credit 3.1, EQ Credit 4.1, EQ Credit 4.2. Additionally, the project team must hold a sustainable design charrette, complete an energy model, and complete a life-cycle cost analysis of building materials and design features. As of 2014, the State of Utah has elected to move away from LEED in favor of a system devised by the state's Division of Facilities Construction and Management. However, the updated law still allows for LEED certification when requested by building users/donors.

30. VA 2007

US-VA-2007-Executive Order 48: On April 5, 2007, Governor Tim Kaine signed Executive Order 48, "Energy Efficiency in State Government," which set out to reduce non-renewable energy purchases and increase overall energy savings. As part of instituting the energy saving goals, the order instructs all state agencies and institutions constructing state-owned facilities over 5,000 gross square feet in size, and renovations of such buildings valued at 50% of the assessed building value, shall be designed and constructed consistent with the energy performance standards at least as stringent as LEED (including the use of Virginia forest products with alternate certifications) or EPA's Energy Star rating. In addition, the order instructs the Commonwealth to encourage the private sector to adopt energy-efficient building standards by giving preference when leasing facilities for state use to facilities meeting LEED or Energy Star.

US-VA-2009-Executive Order 19: On July 1, 2010, Governor McDonnell signed Executive Order 19, "Conservation and Efficiency in the Operation of State Government." Executive Order 19 directs all state agencies to conserve energy, water and reduce waste by requiring that all new or renovated buildings conform to LEED Silver standards or Green Globe Two-Globe standards and by only leasing LEED certified or Green Globe Certified office space.

US-VA-2012-Chapter 793: On April 18, 2012, the state of Virginia enacted Chapter 793, requiring an executive branch agency or institution entering the design phase for the construction of a new building greater than 5,000 square feet to conform to the Virginia Energy Conservation and Environmental Standards, which incorporate LEED standards.

US-VA-2013-Chapter 806: On May 3, 2013, the State of Virginia enacted Chapter 806, requiring that all new and majorly renovated (above 50% of the structures assessed value) state-owned facilities over 5,000 square feet be designed and constructed in a manner consistent with energy performance standards at least as stringent as the U.S. Green Building Council's LEED rating system.

US-VA-2014-Reg. 13VAC10-180: On January 1, 2014, Reg. 13VAC10-180 became effective in the state of Virginia. It revises the qualified allocation plan for affordable housing projects, maintaining rewards for developers that achieve LEED certification. Developers that achieve LEED silver certification receive 15 points, Gold receives 20 points, and Platinum receives 45 points. These points are combined with other building and affordability factors and added up to determine which projects will receive funding.

31. WA 2005

US-WA-2005-Chapter 39.35D: On April 8, 2005, Governor Gregoire approved Chapter 39.35D of the Revised Code of Washington, "High-Performance Public Buildings," requiring all projects over 5,000 square feet that enter into project design after July 24, 2005 and that are receiving capital funds to be certified to the LEED Silver standard. This applies to all state agencies, state prisons, community colleges, universities and more. The code also requires that all K-12 schools be certified to the LEED Silver standard or built to comply with the Washington Sustainable Schools Protocol as of July 1, 2007. In addition, the code required all affordable homes receiving money from the state's Housing Trust Fund after July 1, 2008, to be built in compliance with the Evergreen Standard for Affordable Housing. By 2009, all new construction projects and major renovations receiving Washington State funds will be built to a green standard.

32. WI 2006

US-WI-2006-Executive Order 145: On April 11, 2006, Governor Jim Doyle signed Executive Order 145 Relating to Conserve Wisconsin and the Creation of High Performance Green Building Standards and Energy Conservation for State Facilities and Operations. The Executive Order directs the Department of Administration to establish and adopt guidelines based on LEED for New Construction and LEED for Existing Buildings within 6 months. Any project that requests LEED certification as part of the initial project request will be supported by Department of Administration.

Appendix B3. Research Assistant Coding and Training Protocol

The Green Building Project:
A Guide to the Lobbying Registration Database

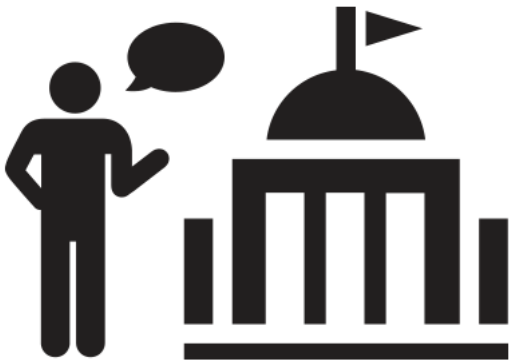


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Table of Contents

I. The Lobbying Registration Database

This project is part of Qianhui Li's doctoral dissertation that discusses the development and performance of voluntary environmental programs (VEPs). This project plans to derive the subjects of lobbying registrations in all 50 states from text analysis and machine learning techniques, and contributes to our understanding of the effects of green building policies. To achieve this goal, human coders are needed to classify part of the lobbying registration data into pre-determined categories. The objective of the manual coding effort is to 1) create a national database of lobbying registrations related to green building policies, 2) serve as an input for automatic text categorization and 3) prepare data to examine the impacts of green building policies.

The lobbying registration database for this project contains information from two databases collected respectively by a private company *illumis*, and a non-profit organization, the National Institute for Money in State Politics (FollowTheMoney). The aggregated database includes over 4 million registration data. Two research assistants will be assigned to code a small subset of the data into different categories and sort out those more related to green building issues. Automatic text categorization techniques will then be adopted to complete the remaining coding. Lobbying registrations related to green building might take a relatively small proportion of the total number of lobbying registrations (compared with the issues such as healthcare and education). If this is true, changes of lobbying registrations in other issue areas may conceal the registration changes in the area of green building. Thus, the coding effort would be crucial to the overall quality of this research.

This guide describes the protocol used to code lobbying registrations. It also provides background on green buildings and a listing of state lobbying registration requirements.

Research Assistant
Mission and Duties

Mission

The mission of research assistants is to examine and code text from the Lobbying Registration Database and to participate in discussions aimed at improving the quality of the database. Research assistants will be working with the principal investigator, Qianhui Li, on a weekly basis. Researchers are expected to be active in identifying problems, asking questions, and making suggestions.

Duties

1. A research assistant will be allocated an average of 20 hours per week in the summer term (or 15 hours per week in the fall term) towards coding texts, maintaining contact with the principal investigator, and attending weekly meetings.[37]

    a. The assistants will be provided the Lobbying Registration Project Research Assistant Guide upon starting the project. This guide will include project goals, coding procedures, the coding system, and the record-keeping responsibilities of the assistants.

    b. The assistants will be trained through a workshop at the beginning of their employment.

    c. Each week the assistants will be assigned data to code.

2. The research assistants will attend a weekly meeting to discuss the project and submit work.

    a. The principal investigator will hold a weekly meeting with the assistants to review work from the prior week. At the meeting, coding problems should be addressed.

    b. Every two weeks, the assistants should submit the "Research Assistant Biweekly Progress Report" to the principal investigator via email or Box folder upload. The document should include the assistant' name, date of the report, and a summary of the coded work (see page 6 for an example).

[37] Individual research assistants might work more or fewer hours as assigned by the principal investigator.

Research Assistant
Biweekly Progress Report

Name: _____

Date: _____

* Be sure to submit this document biweekly in order to ensure quality control.

Documents Abstracting and Coding	Date	Amount Coded	Hours Worked	Approximate Work Rate
e.g. Lobbying Interest coding	7/20/2021	240	4 Hours	60/hour

1. What problems or conflicts occurred during the coding?

2. Please list any records that you feel do not fit into the topic categories – ones that need to be discussed in order to find a common ground.

3. What was your thought process in deciding tough categorizations of topics? Feel free to provide specific examples as appropriate.

4. Are there any other concerns or questions that you have?

II. The Process of Coding

How to Code

There are two general steps in creating a data entry for the Lobbying Registration Database. The first step is the coding of a subject type. This entails a series of decisions about whether the registration is related to some categories. The second step is to conclude data relevance with the categorization of issue type. All the coding work should be conducted using the codebook. The following sections describe the steps in more detail.

Coding Preparation and Useful Links:

1. Each assistant will receive a Box@UA Drive folder invitation. The folder is named as "Lobby_Coder_NAME".
    a. You can get access to the folder anytime through the link: box.arizona.edu
    This folder contains all of the necessary documents for the coding process.
    b. If you don't have a Box@UA account, you can follow the instructions below to create one (link: https://it.arizona.edu/service/boxua)

    1) Visit account.arizona.edu and log in with your NetID and password.
    2) Click the Manage Your Accounts button on the left menu.
    3) Under Available Accounts, click on the Box button to create your account.
    4) Log in to your Box@UA account by going to box.arizona.edu.

2. To code your assigned work, you need to download Box Drive to your desktop.
    a. Link: https://www.box.com/resources/downloads
    This allows you to easily save your edits automatically back to the Box Folder without manually downloading and uploading files.
    b. Once you have installed Box Drive, you can open and edit files directly from Box.
    1) Click the file to open it in preview
    2) Click Open on the right top. The file will pop up in the native application (Microsoft Excel for instance)
    3) Edit and simply save your changes in the native application. All changes will be saved back to Box automatically as a new version of the file.
    4) You will see a status display stating, [*Filename] has been successfully saved to Box.*

3. You may choose to add the Zoom extension to Box (not required)
    a. Instruction link: https://support.box.com/hc/en-us/articles/360047562653-Using-Box-for-Zoom
    This allows you get access to our Zoom meetings directly from the Box folder. This might be useful when we review the documents together during our meetings.

4. Important files in the Box Drive folder:
    a. RA Guide – includes project overview, team contact info, coding guide, and codebook/data dictionary.
    b. RA Biweekly Progress Report Folder – contains all the biweekly progress reports of RAs
    c. Coding Questions Log – stores questions you have about how to interpret and code texts in the assigned dataset.

Coding:

1. Navigate to your assigned dataset and fill in your name code in column D.
    - 01 - Hajar Falouhi
    - 02 – Allison Sauer

2. Taking the first uncoded observation (row) in your assigned dataset, read the text in column C (*lobbyist_interests*), and decide your answers to these following questions, based on the definitions provided below in the Codebook. Note that each observation (row) can be coded as 1 in more than one category:
    a. Does column C include any names of a specific company or specific legislation?
        ◊ If yes, make a google search (for the company homepage or legislation information page) and include your referred webpage in column E (*support_info*)
        ◊ If no, skip to next data entry
    b. Does column C mention any manufacturing sector affairs?
        ◊ If yes, enter 1 in column F (*c_manufacture*)
        ◊ If no, enter 0 in column F (*c_manufacture*)
    c. Does column C mention any environmental issues?
        ◊ If yes, enter 1 in column G (*c_environment*)
        ◊ If no, enter 0 in column G (*c_environment*)
    d. Does column C mention any construction or property issues?
        ◊ If yes, enter 1 in column H (*c_construct*)
        ◊ If no, enter 0 in column H (*c_construct*)
    e. Does column C mention anything related to green building policies but does not fit into any of the above categories?
        ◊ If yes, enter 1 in column I (*c_others*)
        ◊ If no, enter 0 in column I (*c_others*)
    f. Does column C include anything you are unsure meets the qualifying criteria?
        ◊ If no, skip to next data entry
        ◊ If yes, enter 1 in column J (*c_unsure*). Please include this into the Coder Questions Log (see page 9). Each *c_unsure* question will be reviewed and discussed during the next team meeting.
    g. Does column C require more information?
        ◊ If no, skip to next data entry

- ◊ If yes, enter 1 in column K (more_info). For example, there might be text like "Legislation which would have an effect on the interest of the employer", then you might need information on the employer's name and its products/services. Remember to enter 1 for such observations and the principal investigator will supplement with more information.

3. Add up values in column E, F, G, H, I and J by typing the SUM formula into column L (*relevance*).
    - e.g., L2=SUM(F2:I2)

Table of Coding Questions Log

Week 1: Aug 2- Aug 8

No.	Lobby_interest	Concerns	Possible category(s)	Supplemental info	Final decision
000001					

Week 2: Aug 9- Aug 15

No.	Lobbying_interest	Concerns	Possible category(s)	Supplemental info	Final decision

Codebook

Subject Type Coding Scheme

Code	Category
11	Manufacturing Sector Affairs
12	Environmental Issues
13	Construction & Property Management
199*	Others: Related to Green Buildings

* The 99 subcode is designed for data that relates to the overall policy topic of green buildings but does not fit into any of the existing codes of this topic (refer to page 14 for a definition of green buildings).

11: Manufacturing Sector Affairs

This category refers to any affairs related to the manufacturing sector (please refer to https://www.hq.nasa.gov/iwgsdi/Manufacturing.html for details of included industries). The manufacturing sector in this guide usually relates to heavy-polluting industries (e.g., chemical and allied industry, apparel industry, paper industry, transportation equipment industry[38]). They are described as plants, factories, or mills. The process of transforming raw materials or parts into finished goods often contributes contamination of air, water, soil, animals, and other resources. To have building materials go green, manufacturing need cost more than their typical, environmentally harmful activities. Therefore, manufacturing industries are likely to get involved in lobbying activities regarding green building policies. Other industries including, but not limited to, agriculture or food production[39], financial services, telecommunications[40], and entertainment, are usually not related to green building affairs.

[38] Transportation equipment industry includes the manufacture of products such as motor vehicles, aircraft, guided missiles and space, vehicles, ships, boats, and railroad equipment. This does not include the traditional transportation sector that provides services to move people or goods. The focus of the definition is "manufacturing" rather than the "movement services". Based on this, airlines, shipping, and logistics that provide transportation services are not included in this category.

[39] Includes tobacco planting and production etc.

[40] The telecommunication sector is made up of companies that transmit data in words, voice, audio, or video across geographical boundaries, whether it is through the phone or the internet (wires or wirelessly). It includes telocom equipment, telecom services, and wireless communications. According to the North American Industry Classification System (NAICS), it is not related to the process of transforming raw materials to a finished product, and is not classified into the manufacturing sector.

Manufacturing affairs include manufacturing strategy, technological capacity of manufacturing industries, state assistance in industry revitalization and growth, decline in state industrial productivity, plant closings and relocation, commission on productivity, etc.

Examples: "All legislation impacting manufacturers", "Any and all matters concerning Illinois Tool Works, Inc.", etc.

12: Environmental Issues

Environmental issues reflect the growing public concern of human impacts on the biophysical environment. This category often focuses on climate, air pollutants, water quality, waste and recycling, and more. There are four sub-categories to help coders understand this category but it is not necessary to include a subcategory in the coding.

Subcategory 121: Environment in general

This includes state implementation of major environmental regulations (i.e., air, water, waste), global warming, species and forest protection, land and water conservation, coastal water pollution and conservation, regulation of hunting, fishing, and recreational boating, etc.

Subcategory 122: Energy

There are many different forms and sources of energy. Government regulations may be adopted to change the production, distribution, and consumption of different sources of energy, including fossil fuels such as coal, oil, and natural gas, as well as renewable energy sources such as solar, wind, nuclear, and hydroelectric power. Lobbying subjects regarding energy can be energy efficiency in the state government, home energy efficiency programs, community energy efficiency act, energy conservation in cities, establish building energy performance standards, diesel fuel and gasoline conservation, promotion of carpooling, motor vehicle fuel efficiency.

Subcategory 123: Natural resources

Population growth and urban development have driven resource scarcities, which fueled increasingly contentious debates and confrontational politics over natural resources and their uses. Numerous laws and regulations regarding natural resources and public land management have been published. This subcategory reflects interest groups' concerns of natural resource uses and government ability in regulating. Examples include timber issues, forest health and clear-cutting, wilderness area designation, management of old forest growths, mine reclamation, various public lands bills, forest fire prevention and control, modification of public land boundaries, management of livestock on public lands, enforcement of federal and state mining standards, development of mineral resources on public lands, mineral exploration and development, conveyance of public lands to school districts or other local governments, conveyance of sewage systems on public lands, protection of archeological resources on public lands, conveyance of public lands, payments to the state from receipts derived from national forests located within the state, protecting the shores of publicly owned property.

Subcategory 124: Indoor environmental hazards

This subcategory can be directly related to the green building standard. This includes indoor air quality and radon disclosure and abatement legislation, lead exposure reduction, childhood lead poisoning prevention, public schools asbestos inspections, management and control of asbestos in government buildings, programs relating to indoor air contamination, airliner cabin air quality, health effects of exposure to low level radiation from video display terminals, regulation of indoor disinfectants.

Examples: "waste management", "All legislation and rules affecting existing or proposed operations of electric and/or natural gas utilities", etc.

13: Construction & Property Management

This category puts together interests regarding building and houses, public works, and industrial-type structures. Buildings include both residential homes and commercial projects. They may involve renovations on existing buildings or building from scratch. Establishment works involve the construction of roads, railways, water and wastewater distribution and purification systems, damns, and bridges. Finally, industrial projects include refineries, pipelines, power utilities, manufacturing plants, and telecommunication infrastructure. The work performed may include new work, additions, alterations, or maintenance and repairs.

Subcategory 141: Housing programs

This subcategory focuses more on lobbying reactions to state building codes and regulations. This includes state community budget requests and appropriations, housing and the housing market, state building codes, building construction standards, health of the housing industry, state housing assistance legislation, administration and operation of state housing programs, housing safety standards, land conveyances for economic development programs.

Subcategory 143: Property & land management

Government or private owners can implement different planning processes to manage each project or parcel of land. There are many subjects that concerns the interest groups, including state government and Department of General Services (DGS) management of public building leases, relocation assistance and property acquisitions, rental policies and procedures, etc.

Subcategory 142: Construction of different facilities

This subcategory includes any construction projects regardless their uses. For example, construction of hospitals, laboratories, schools, research center, emergency care facilities, etc.

Examples: "Brownfield development", "Short-term rental regulation", "All legislation and regulatory activity which could impact the business of property/casualty insurance", etc.

Relevance Coding Scheme

Code	Category
0	Irrelevant
1	Relevant (belongs to any of the above 1x categories)

The coding will be a 0/1 scheme – whether the observation will be relevant to the green building policy or not. After coding of all the subject categories above, calculate the sum of these categories. If the sum is 0, then code its relevance as 0. If the sum is 1 or larger than 1, then code its relevance as 1, which means this data entry is relevant to green building policies.

III. Supporting Materials

1. Definition and History of Green Building (EPA): https://archive.epa.gov/greenbuilding/web/html/about.html

   "Green buildings are designed to reduce the overall impact of the built environment on human health and the natural environment by:

   1) Efficiently using energy, water, and other resources
   2) Protecting occupant health and improving employee productivity
   3) Reducing waste, pollution and environmental degradation."

2. Lobbyist Registration Requirements (NCSL): https://www.ncsl.org/research/ethics/50-state-chart-lobbyist-registration-requirements.aspx

   To lobby, a company must register with the state they are lobbying in and also often hire a third-party lobbyist to conduct the lobbying. The observations in this dataset (one observation per row) detail the client and lobbyist registrations for different issues.

3. …….

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