INSTITUTION BUILDING IN AN EMERGING INDUSTRY: LESSONS FROM THE CARBON OFFSET INDUSTRY

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Dedication

It was about ten years ago, when I decided to change course. Life was nice. I had a good job in civil engineering. I was married to a beautiful wife, and had two cute boys. I had bought and renovated two condos. I realized that I could continue to work and save, and invest in real estate, which I really enjoyed. But I had a problem. I liked earning, saving, and investing money, but I didn't really want to spend it. Childhood experiences with financial ruin and two years living among the poor in Nicaragua had left me with an enduring desire to use my time and resources to make life better for the poor. I realized that I could do what I'd seen others do, by working and saving throughout my career, and then go try to help others. Yet I realized that I wanted to be personally involved in the helping, and that making a lasting impact is really difficult. And working in engineering would not really help me to figure out. So I decided to change careers and try to use my career to find better ways to help through business.

The path since that day has been long and winding. I underestimated the difficulty of accomplishing my original goals and at the same time produce high quality research that contributes to management research. My idealism tended to hinder practicality. But in the end, I feel like I've been able to couple my interests in the poor with my recognition that I need to contribute to research in my field. I am not entirely satisfied that this dissertation directly contributes to understanding how to improve business to the benefit of the poor. However, I do feel like it's a step in that general direction that may speak to a broader audience than those who are just interested in helping others.

So I dedicate this dissertation to the many who wish business and industry would work better for them and their families.

Abstract

Industry creation requires the building of institutions that support and enable economic exchange. Among the many actors involved in building these institutions are firms. The three papers of this dissertation investigate how firms are involved in the process of building these institutions in the context of the global carbon offset industry from 2003 to 2011. In the first paper I draw on the innovation management literature to contrast two ways in which the public and private sector can interact in the rulemaking process. I illustrate these differences by comparing the development of rules in two different carbon offset systems: the Clean Development Mechanism (CDM) and the Climate Action Reserve. In the second paper, I test whether the 152 firms among the population of 1599 firms operating in the CDM benefit from choosing to help build the rules that are needed for all firms to operate in the CDM. I find that, in addition to providing a collective good for the entire industry, these institution-building activities provide firms visibility among potential customers. In the final paper, I find that institution-building actions in the CDM tend to signal the presence of potential competitors, which deters local industry growth among the 91 developing countries which host carbon offset projects. Prior commitment and capabilities of local country governments positively moderate this relationship. Collectively, these findings demonstrate the important role of firms in shaping the institutions that support industry emergence and influence industry evolution.

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Abbreviations

CAR	Climate Action Reserve
CDM	Clean Development Mechanism
CERs	Certified Emission Reductions (carbon offsets used in Clean Development Mechanism)
DNA	Designated National Authority
DOE	Designated Operational Entities – Validator and/or Verifier
GHG	Greenhouse Gas
PDD	Project Design Document
PIN	Project Implementation Note
CRTs	Climate Reserve Tonnes (carbon offsets used in Climate Action Reserve)

1. INTRODUCTION

Revolutionary changes in economic, organizational, and social life often come from new industries. Much of the "creative destruction" caused by entrepreneurship is related to the creation of new industries that disrupt former economic patterns (Schumpeter, 1934). However, industry creation tends to be understudied compared to organizational activities in established industries. The reasons for this are many. Although the period of emergence can stretch for many years, it may also be short (Forbes & Kirsch, 2011). Thus, data is more difficult to obtain in emerging industries. It is often unclear exactly what the boundaries of the industry are and firms often fail before data collection begins (Aldrich & Fiol, 1994). Moreover, some industries fail to emerge and wane from the collective memory.

This dissertation focuses on one important component of the industry creation process: the process of building the infrastructure of institutions that support economic exchange within the emerging industry. Institutions include taken-for-granted assumptions, norms of appropriateness, and rules and regulations that help provide stability and predictability in human interaction (North, 1990; Scott, 2001). On the other hand, industry creation creates new relationships, and often happens along with institutional change. Thus, this dissertation contributes directly to recent research at the intersection of institutions and entrepreneurship provides (Tolbert, David, & Sine, 2011). In particular, this study explores the ways in which institutional actors, often called institutional entrepreneurs, help to build institutions, and thereby influence the emergence of an industry.

The context of the study is the emerging global carbon offset industry, which consists of the firms that design and develop projects that result in reductions of greenhouse gas (GHG) emissions from 2003 to 2011. This industry is very important in practice, as it represents the largest scale market-based approach for dealing with environmental externalities. Carbon offsets, also known as carbon credits, are the products produced by carbon offset firms. They account for $142 billion in trade in 2011(Linacre, Kossoy, & Ambrosi, 2011). Moreover, it is the largest experiment in market-based approaches to deal with climate change. Lessons learned from the development of the carbon offset industry may provide lessons for future market-based approaches to economic externalities. Moreover, it provides me a unique setting in which the actions of firms to help create the rules for an emerging industry are uniquely observable.

One of the principal contributions of this dissertation is the gathering of detailed quantitative and qualitative data on the carbon offset industry. During industry emergence, it is often very difficult to gather good data on firms in the industry since there is no organization that is recording the actions of the firms. The carbon offset industry is unique, in that very detailed project-level data has been compiled by the United Nations. This data has been archived on the internet by the United Nations, and has been compiled in databases maintained by the UNEP Risoe Center, the Institute for Global Environmental Strategies, and other for-profit consulting companies. Data on methodologies and other details of the CDM are available through the United Nations, but they are often difficult to use. What is not available from any of these public or

private databases is information on the firms operating in the industry. I have gathered this firm-level data. In order to accurately gather firm-level data that could be merged with the available project level data, I attended two professional conferences, interviewed over 40 industry professionals, and gathered data on carbon offset firms through web searches, phone calls, and e-mails. This data collection effort is particularly valuable, since the future of the carbon offset industry after 2012 is under substantial uncertainty due to the conclusion of the Kyoto Protocol's initial commitment period.

Another unique aspect of the carbon offset industry is the ability to observe how firms are involved in building the institutions that support the industry. This occurs through the creation of methodologies in the carbon offset industry. Methodologies stipulate procedures, calculations, and rules for designing and quantifying carbon offsets associated with a particular industrial process. Methodologies are needed in order for a carbon offset industry to function. The methodology creation process in the carbon offset industry involves both the public and private sectors, and records kept by the U.N. allow an unprecedented ability to observe the actions of specific firms in helping to create methodologies. By observing one type of the institution-building process in great detail, I complement prior studies that have focused on other types of institution-building in other emerging industries. In the table below, I situate this type of institutional work relative to other institutional work explained in related studies of emerging industries. Subsequently, I describe how methodology creation compares to other institution-building processes.

Table 1: Institutional Infrastructure and Industry Creation

Studies	Industry Setting	Principal Institutional Actors and Activities
Dissertation	Carbon offsets in 91 countries, 2003-2011	Firms (and non-profit organizations) help to create rules for governing creation of carbon offsets. Local governments help in this process.
(H. Rao, 1994, 2004)	Automobiles in U.S., 1895-1912	Certification contests by automobile clubs helped to build the industry's legitimacy, increase firm foundings, and establish firm reputations.
(Weber, Heinze, & DeSoucey, 2008)	Grass-fed beef in U.S., 1990's	Social movements created cultural understandings, enabled a collective identity, and create exchange between producers and consumers.
(Sine, Haveman, & Tolbert, 2005; Sine & Lee, 2009)	Alternative Energy in U.S., 1978-1992	Social movements helped establish taken for-grantedness and norms that led to increases in government financial support and favorable court rulings. Trade associations favored existing technologies, and firms based on these technologies. Media accounts increased acceptance of alternative energy firms that led to more foundings.
(Hiatt, Sine, & Tolbert, 2009)	Soft drinks in U.S., 1870-1920	Social movement organizations prompted regulations mandating temperance instruction and prohibition regulation that indirectly favored emerging soft drink industry.
(Hiatt, 2010)	Biodiesel in U.S., 1990-2008	Trade associations promoted and legitimated technologies, also influenced supportive regulations
(Pacheco, York, & Hargrave, 2011)	Wind power in U.S., 1999-2008	Social movement organizations, some firms, and trade associations influenced legislation (by lobbying and forcing a popular vote) supporting the wind industry (i.e. renewable portfolio standards, incentives).
(Garud, 2008)	Cochlear implants, 1984-1988	Firms, academics, and government panels contest standards at conferences that define an emerging organizational field.
(Rosenkopf, Metiu, & George, 2001)	Cellular phones, 1990-1995	Firm participation in cooperative technical helps firms to build future alliances
(Woolley, 2011)	Nanotechnology global, 1976-2009	Technical experts from academia, industry organizing conferences. Governments provided funding..

At a detailed level, methodologies are most similar to standards, which have been labeled as decentralized institutions (Meek, Pacheco, & York, 2010). Methodologies give guidelines for the development of carbon offsets. Similarly, in network industries, standards committees make choices about technology standards so that products from different firms can effectively interface. Thus, standards enable and constrain product design and functionality. The creation of methodologies also provides a collective good similar to a standard that demonstrates how a technology should work (Rosenkopf et al., 2001). Thus, methodologies, like standards, make it less costly for all firms to operate in the industry.

Methodologies are also dissimilar to some of the standards that are typically studied. First, methodology creation conveys no property rights to the parties involved in the creation process. Sometimes a particular firm's technology is chosen as the standard, which effectively gives the firm a form of property rights. However, in the carbon offset industry, methodologies do not convey property rights. Moreover, there is often a single standard for an industry, which can lead to standards wars. However, there are many potential methodologies that can be used to develop different types of carbon offsets.

Methodologies are also similar yet different than the regulations typically studied in industry creation. Methodologies are like regulations that sanction certain means for accomplishing particular activities. These types of regulations are associated with more highly regulated industries such as mining, gambling, financial services, and hazardous waste removal (among others). There are numerous government agency rules stipulating how organizations need to act in these industries. These rules differ from rules and

regulations that give financial incentives or direct support to certain types of activities, which are the focus of the institutional accounts of industry creation shown above. Thus, methodologies deal more with specifying *how* carbon offset are created, rather than regulating the *legality* or *price* of carbon offsets.

A core claim of this dissertation is that, despite the idiosyncrasies of the context, the process of methodology creation is a type of institution building activity similar to other types of institution-building activities that have been identified in prior research. Norms of appropriateness, taken-for-granted assumptions, and regulations can reduce uncertainty, facilitate interaction between firms, regulators, consumers and producers, and lower the costs of business in an emerging industry. Similarly, each additional methodology creates new opportunities in the industry (Sine et al., 2005) by lowering the costs of developing new types of carbon offset projects. Further investigation of this process comprises the remainder of the dissertation.

This dissertation consists of three related studies, which comprise Chapters 2-4. The first study (Chapter 2) is entitled "Modularity in Rulemaking." Industry creation requires the efforts of many different types of organizations. One important part of the industry creation process is the creation of rules that effectively regulate economic activity in the industry. Rulemaking often requires the input of both the public and private sector. While a considerable literature deals with *the degree* to which the private sector is involved in rulemaking, in this paper, I seek to describe *the pattern* of how the private sector interacts in creating rules for the emerging carbon offset industry.

I draw on the innovation management literature to contrast two different patterns by which the private sector can be involved with the public sector in the rulemaking process. Rulemaking is a type of policy innovation in that each new rule is a type of innovation. In an *integrated* rulemaking system there is a high level of interaction between the public and private sector in creating rules. Most rulemaking systems are integrated, in that members of the private sector and the public sector sit around a table to come to a consensus on workable rules. Their actions are very interdependent. A far less common method of coordinating activities is a *modular* system, in which the public and private sector have little interaction and are able to create components of the rule system independently. Modularity, a property of applicable to any type of system, allows for the parallel experimentation. Modularity has not been applied to understanding the interactions between the public and private sector in rulemaking.

I illustrate these two alternatives using details from two different carbon offset systems: the United Nations' Clean Development Mechanism (CDM), and California's Climate Action Reserve (CAR). Both systems provide a framework and specific rules for developing carbon offsets. The contrasts between the CDM and CAR illustrate the benefits and costs of modularity in policymaking. Modular policy innovation allows policymakers to access a much broader variety of knowledge from the private sector. Private sector actors that typically have limited access in an integrated policymaking process particularly benefit. These include new, smaller, and less legitimate organizations. On the other hand, the increased access from organizations on the

periphery may increase innovation variety, but may lead to many policy innovations that are less effective, as has happened in the CDM.

I leverage the unique characteristics of the CDM to study the process of institution building in Chapters 3 and 4. In my second paper (Chapter 3), entitled "Private Benefits from Institution Building," I study the degree to which firms that are involved in the building of institutions for a new industry receive an individual private benefit, in addition to the collective good that this institutional infrastructure creates for the entire industry. Prior work at the intersection of entrepreneurship and institutions has indicated that institutional change creates entrepreneurial opportunities (Sine & Lee, 2009). However, I depart from prior research in two respects. First, prior research has implicitly assumed that institutions act exogenously on entrepreneurs and an emerging industry. The institutional entrepreneurs have been acting on the industry from the outside. These include social movements, hobbyists, or industry associations who have created institutions that favor the emergence of the industry (H. Rao, 1994; Sine et al., 2005; Sine & Lee, 2009). In contrast, I study the actions of firms *within* the emerging industry to help build the institutions that support their own industry.

The second way in which I depart from prior research is that I measure firm-level effects of institutional entrepreneurship. Prior research has focused at the population level, showing that institutional change creates opportunities for the entire industry. It is true that much of the institutional infrastructure that supports an industry benefits all firms in the industry. I argue that even if firms that help build an industry's institutions for the collective benefit do not directly benefit from this institutional work, they may

indirectly benefit from the positive signal of the firm's characteristics that is created by the process of institution-building. I also argue that firms that have characteristics that indicate a lack of commitment to the industry or lack of quality are likely to benefit more from institution-building.

I test whether visible involvement in rulemaking, one type of institution-building, demonstrates leadership and commitment within an emerging industry that helps firms to attract customers. The research context is the CDM, in which 1599 firms have developed 9,045 carbon offset projects in developing countries between 2003 and 2011. Analysis supports the main hypothesis that institution building benefits a firm because it provides a signal of the firm's characteristics. Results also indicate that firm characteristics moderate the signaling effect of institutional entrepreneurship.

In the third paper (Chapter 4), entitled "Spillover Effects of Institution Building," I study the degree to which institution building, which creates institutions that affect the entire industry, also provide additional spillover effects around the location of institution building. Whereas the Chapter 3 focuses on the private benefits of institution building, Chapter 4 focuses on benefits to those that are proximate to the institutional entrepreneurs.

I argue that institution building not only provides a signal to potential customers that the firms involved in institution building are capable and committed to the industry; it also provides a signal to potential industry entrants. Institution building provides two clear signals: first, that a potential competitor is present and involved in the industry, and second, that there are other proximate institutional actors that are helping to support the

industry. I argue that depending on the details of the context, these two countervailing signals may lead to either increased or decreased growth in an industry. I argue that this signal is positively moderated by consistency among institution building activities and when other institutional actors (in addition to the firms) are more capable.

I again test my hypotheses in the context of the CDM. I find results indicating negative spillovers (institution building actually has negative subsequent effects on the local industry). Moreover, I find support for my other hypotheses regarding the moderation .

Finally, in chapter 5, I offer concluding remarks regarding the significance of the dissertation as a whole, and the contributions that it makes, both to theory and to practice. I also add some details on future directions for research that this dissertation might motivate.

2. MODULARITY IN RULEMAKING

2.1. INTRODUCTION

Public and private actors are inherently interdependent in accomplishing public and private interests (Mahoney, McGahan, & Pitelis, 2009), especially in new industries. Scholars of non-market strategy, social movements and institutions have demonstrated how private actors, both for-profit and non-profit organizations, influence and are influenced by the regulative institutions governing an industry and influence the creation of new industries (Bonardi, Holburn, & Vanden Bergh, 2006; Lee, 2009; Sine & Lee, 2009).

Much of the research emphasis has focused on the *degree* to which the private sector is involved with the public sector in creating regulations. Prior research demonstrates that both command-and-control regulation (created by policymakers) and self-regulation (created by the private sector) have significant shortcomings (Delmas & Marcus, 2004; King, Lenox, & Terlaak, 2005; Lenox & Nash, 2003; Majumdar & Marcus, 2001). Coordination between public and private sectors in rulemaking can lead to increased flexibility for firms in dealing with rules as well as effectively achieving policy objectives (Delmas & Marcus, 2004; Delmas & Montes-Sancho, 2009; Majumdar & Marcus, 2001). Indeed, most regulatory frameworks are a hybrid of these two traditional regulation models, with both the private and public sectors contributing to the rulemaking process (Gunningham, 2009).

However, research has not yet examined how the structure of coordination between public and private sector actions in creating new policy and rules. The policymaking and

rulemaking processes are a type of policy innovation in which new policies to achieve policy objectives are created (Mintrom, 1997). This lack of attention on how best to coordinate public and private sectors actors in policy innovation is somewhat surprising since the world's most pressing problems seem to require new and innovative policies. Nowhere is this more important than in emerging industries where new rules are often needed, and where policymakers' knowledge might be particularly .limited.

In this paper, I investigate how differences in the structure of joint actions of public and private actors in rulemaking influence new industry creation. Specifically, I ask how opening up the process of rulemaking so that private sector actors can more fully participate, impacts patterns of industry emergence and policy innovation. I develop my arguments by making detailed observations of the unique rulemaking processes dealing with one of the most significant current global policy problems – climate change. I focus my analysis on the interaction of the emerging industry of firms that create carbon offsets with regulators that create carbon offset systems. Carbon offsets, which are financial instruments that represent greenhouse gas emission reductions, are an important advance in market-based approaches to public policy. I explore the process by which the private sector is involved in producing the rules or standards for generating real and verifiable carbon offsets. Because carbon emissions occur in almost all human activities, there are many technological methods for creating greenhouse gas emission reductions. I label each new standard or rule for matching a particular technological method to policy objectives as a new policy innovation. Thus, this is a unique context for exploring the policy innovation process.

I provide an in-depth description of the rulemaking process of the Kyoto Protocol's Clean Development Mechanism (CDM), and then compare this with the smaller California-based Climate Action Reserve (CAR). The CDM rulemaking process allows private sector actors to create components of the rules governing the industry with little interaction with regulatory agencies. The bottom-up CDM process is *modular*; which means that interdependence between the private sector rulemaking activities and public agency rulemaking activities is low. The CAR rulemaking process also incorporates expertise and input from the private sector, but does so through a top-down, more closely *integrated* process, which requires higher levels of interdependence between the public and private sectors.

I compare and contrast modular and integrated rulemaking processes, as well as the patterns of policy innovation in each regulatory system. A modularized rulemaking promotes greater policy innovation variety. By allowing private actors to develop components of rules in parallel, a regulator can gain access to a much wider range of knowledge, from both profit-seeking and non-profit organizations, than can be accommodated through an integrated rulemaking process. Thus, modular rulemaking systems are more inclusive and flexible, allowing peripheral organizations, such as new ventures, to have greater influence in rulemaking. However, these same organizations that benefit from increased access to the rulemaking process are more likely to be located on the periphery of an industry's current knowledge space. New and revolutionary ideas can come from the periphery, but peripheral knowledge can also be of lesser value to the

rest of the industry. Therefore, a modular rulemaking system is likely to generate policy innovations with high variance in usefulness including many innovation failures.

This paper is organized as follows. First I establish that private sector actors and regulators commonly *jointly* contribute to the rulemaking process. I compare this rulemaking process to a process of innovation in which different parties jointly create an innovation. I draw on research in modularity to contrast two different rulemaking systems (the U.N.'s CDM and California's CAR) within the carbon offset industry. Then I develop propositions, based on arguments from the modularity literature as well as detailed observation of the CDM and CAR that indicate the consequences of a choice of whether to involve private sector actors in a modular or integrated manner. I conclude with implications.

2.2 RULEMAKING AS INNOVATION

The process of creation of rules and regulations is a process of innovation; rulemaking requires recognizing a problem or need, research and development of means to address the need, implementation of the rule, and diffusion or adoption of the rule (Rogers, 1995). The emergence of new industries provides an instructive context in which to observe this innovation process, since rules and regulations do not yet exist and have to be developed for the industry. As Porter states: "The competitive problem in an emerging industry is that all the rules must be established such that the firm can cope with and prosper under them" (1980: 215–216). Various literatures indicate the importance of the creation of rules in an emerging industry, yet they do not directly

address the interaction between the public and private sector in the process of the creation of regulations and rules and how it influences an industry.

A thriving literature in organization theory highlights how organizations that are external to the firms in a new industry are interested and effective at influencing the creation of institutions in a new industry. Relatively more emphasis is given to cognitive (notions of taken-for-grantedness) and normative (related to norms and legitimacy) institutions (Scott, 2001), since regulative (rules and regulations) institutions play a more prominent role in economic arguments. For example, trade associations and certifying bodies establish norms that influence the founding of different types of firms (Sine, David, & Mitsuhashi, 2007; Sine et al., 2005). Consumer groups and social movements make claims that establish the legitimacy of new industries, as well as help to influence regulations that support the emerging industry (Sine & Lee, 2009, 2009). The actions of these organizations tend to shift favor to some firms (based on technology or geographic location) over others.

Entrepreneurs are also often committed to being institutional entrepreneurs as well as the commercial type. For example, Sine and Lee (2009) discuss how one wind company entrepreneur was as deeply committed to the cause of the environmental movement as the performance of his company. This literature indicates that many private sector actors are interested and involved in creating the infrastructure of rules for new industries. However, it provides less insight for understanding the various ways in which firms and regulators interact in building of rules, or regulative institutions in the new industry.

On the other hand, the nonmarket strategy literature indicates that firms indeed play an important part role in influencing the regulations that they face. One stream of this research focuses on the *degree* to which the private sector is involved in the rulemaking process. Trying to create regulations without involvement of either sector has shortcomings. For example, a purely command-and-control approach, in which the regulating authority creates and enforces regulations that govern an industry, is often inflexible and misses opportunities for promoting innovative activity (Delmas & Marcus, 2004; Delmas, Russo, & Montes-Sancho, 2007). On the other hand, self-regulation suffers from free riding, opportunism, and adverse selection (King and Lennox, 2000; Lenox and Nash, 2003). This literature indicates that both firms and regulators provide useful contributions to the policy innovation process. In reality, both public and private actors are involved in rulemaking, such that most rulemaking structures are a hybrid that lies between the centralized command-and-control model of regulation and decentralized self-regulation (Gunningham, 2009).

Private actors, both firms within an industry and other interested organizations, can influence the formation of rules and regulations in two basic ways. First, firms, industry associations (which represent firms), consumer groups, and interested non-profit organizations can directly contact or employ lobbyists to influence elected officials in the policymaking process. Much of the empirical work in nonmarket strategy focuses on established industries in which decisions are more incremental in nature, in which an existing policy innovation undergoes variation or elaboration (Bonardi et al., 2006). This process is fundamentally different from new innovation. Second, they can seek to

influence government agencies and sub-agencies that issue rules that implement government policies. This second process of rulemaking is called the informal rulemaking process and dates to the Administrative Procedure Act (APA) of 1946 in the United States. While elected representatives play an important role in creating regulations, in the United States, government agencies and sub-agencies issue many times more regulations (recently estimated at 4,500 new regulations per year) in the rulemaking process than do legislators in the policymaking process, (Coglianese, 2004). This paper focuses on how private sector organizations can contribute to the rulemaking process in a new industry.

Rulemaking in an emerging industry is an important innovation process that typically involves both private sector actors and regulatory agency staff. This innovative process is similar to product innovation processes involving multiple firms that have been studied in the product innovation literature. While "policy innovation" is used in political science research, this literature draws on basically one strand of innovation literature – diffusion of innovation. These policy innovation studies document the diffusion of new programs, agencies or laws (e.g. school choice laws) across political jurisdictions (Mintrom, 1997; Tyran & Sausgruber, 2005; Walker, 1969). More recently, Lee (2009) investigated the influence of the structure of standards based certification organizations on the adoption and transformation of organic food standards across U.S. states. Each new standard, copied or altered from previous standards, is a policy innovation. Mintrom (1995) highlights the similarities between leaders introducing new ideas in policy and entrepreneurs. However, this literature does not yet attempt to apply concepts from the

innovation literature to understanding better how to structure interactions between the public and private sector in the rulemaking process. Below, I propose that just as two or more firms often jointly produce a product in a modular or an integrated innovation process, the public and private sectors can jointly produce new rules in a modular or an integrated policy innovation process.

Modularity, a property of all types of systems, is the degree to which a system's components may be separated and recombined (Schilling, 2000). A product can be modular, and the process by which a product is produced can also be modular. Modularity is a significant driver of recent advances in innovation (Baldwin & Clark, 1997). Modular system components can be mixed and matched, which means that modular systems are more flexible than fully integrated systems (Sanchez & Mahoney, 1996). The opposite of modularity is integration. Integrated systems trade off flexibility for increased *efficiency*. For example, if components of a computer production process are specially fitted together (and are thus more interdependent), the production system size can be reduced and/or the system performance can be increased (Schilling, 2000).

Modular production processes foster innovations by allowing individual firms to develop *specialized knowledge.* Breaking a design into separable and recombinable chunks that connect through standard interfaces allows more firms to focus in parallel on improving one specialized product or process, without requiring costly adjustments from other firms participating in the same organizational system (Baldwin & Clark, 2000). In this way, multiple individual designers or design teams, with heterogeneous capabilities can simultaneously focus on the same specific task and are free to take different

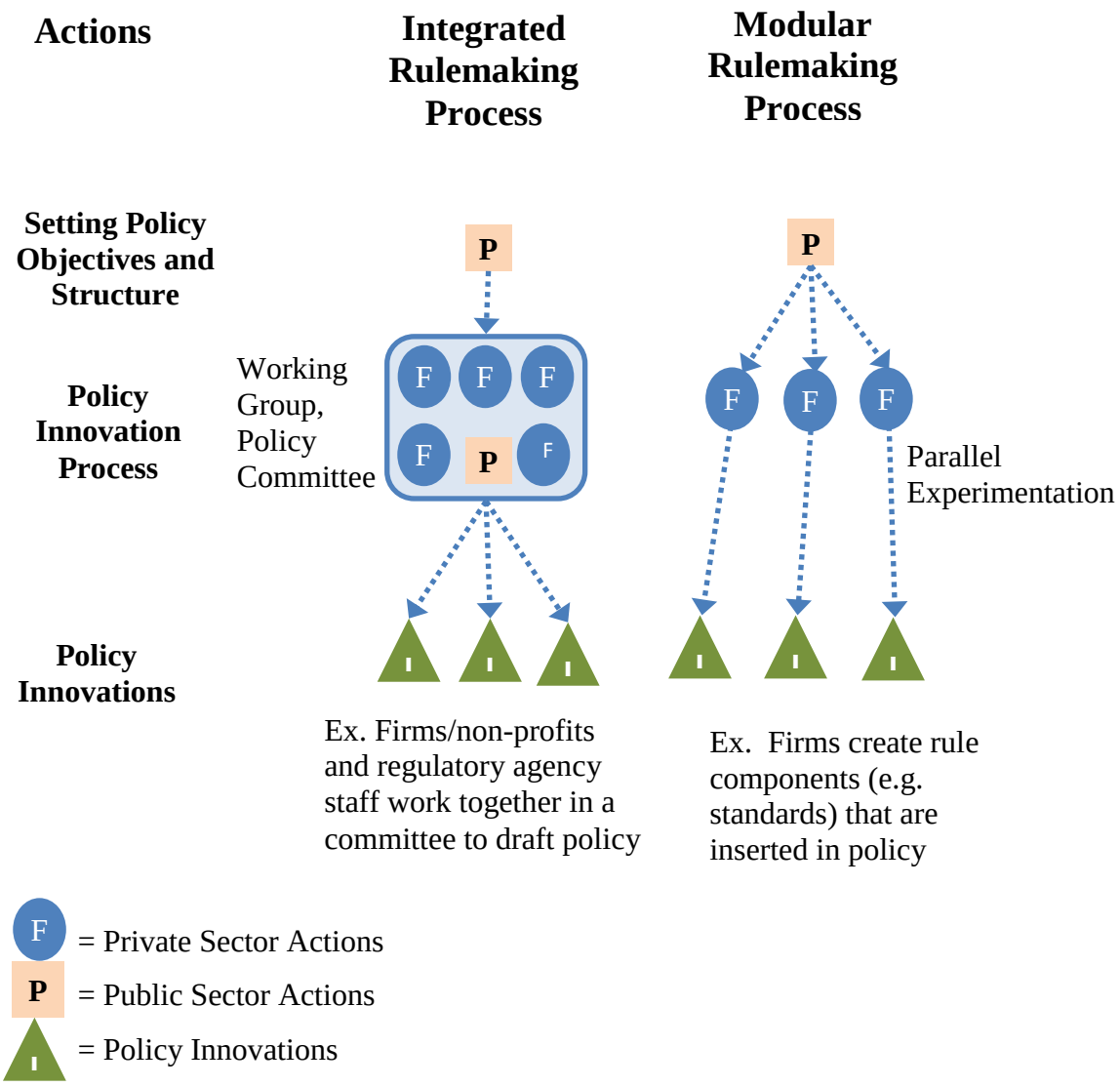
approaches to accomplishing a design. This parallel experimentation among firms leads to more rapid innovation in products as well as the diffusion of innovations (Baldwin & Clark, 1997, 2000; Ethiraj & Levinthal, 2004). The ability for multiple actors to simultaneously develop alternative innovations also minimizes the number of potentially useful innovations that are missed (Baldwin & Clark, 2000; Garud & Kumaraswamy, 1995). Modular production processes have also enabled the development of open source innovation in many different industrial contexts (Bonaccorsi & Rossi, 2003)

Even though Simon (1996) and Schilling (2000) both theorize at a system level, modularity at institutions and policy levels of analysis has been largely ignored. Garud and Kumaraswamy (1995) and Langlois and Robertson (2002) mention modularity at the level of institutions, but limit their discussion to standards. Legal studies indicate that modularity is often used in structuring laws and contracts (H. E. Smith, 2005), but do not discuss the ways in which modularity applies to the process by which laws are created. Yet the principles of modularity certainly apply to the joint efforts of the public and private sectors in creating effective rules.

I define *rulemaking modularity* as the degree to which the actions of a policymakers and private actors are independent of each other in creating components of rules. Rules and regulations are often modular. As mentioned previously, there are numerous examples of specific parts of policies being grafted from one jurisdiction's laws to another's (Lee, 2009; Tyran & Sausgruber, 2005). However, a modular rulemaking process is one in which the activities of the policymaker and the private sector actors that create the components of policy are themselves separable and

recombinable. In other words, there are low levels of interdependence between the public and private sector actors in a modular rulemaking process. Little interdependence does not mean little contribution. For any given level of contribution from each contributor to the innovation, interdependence can range from very high to very low. I assume that both public and private sector actors both play a role in creating rules to some degree. These actions of the private sector actor and the regulator are weakly interdependent in a modular rulemaking system. Therefore, the private sector actor can act unilaterally to create a modular policy component, or policy module. When the policy module fits correctly with the policy framework, a policy innovation is created. Since the policy framework is needed for the policy module to work, the policymaker and the private sector actor are policy innovators together.

Figure 1: Comparison of Rulemaking Systems



An illustration contrasting modular and integrated rulemaking processes is shown in the Figure 1 above. In an integrated rulemaking process, agency staff and firm representatives interact frequently in the rulemaking process. An example of an integrated rulemaking process is when a regulator convenes a policy working group with

members from industry and non-profit sectors to help draft a new rule. The number of people who can physically meet together, reach a consensus, and negotiate is limited. Thus, agency staff has to select which organizations to involve in an integrated process, which may include meetings, negotiations, and frequent back and forth revisions of drafts of proposed rules. In an integrated process it is difficult to distinguish the individual contributions of the private sector actors and the agency staff (this is likely one reason that it is an understudied process).

A modular rulemaking process is one in which the rulemaking actions of the regulatory agency and the private sector actors are less interdependent. Each creates separate components of rules, which are joined together to form a functioning rule. This means that agency staff and private sector actors do not have to have meetings to gain consensus or negotiate. In highly modular systems, similar to an open source software development process, each party does not have to understand all of the inner-workings of other components, but only that their own component interfaces correctly with the other components. An example of a more modular rulemaking process is the informal rulemaking process in which a regulatory agency requests public comments or proposals for accomplishing policy objectives. The Internet has improved access to this process, such that anyone in the world with access to the internet can feasible contribute an idea, opinion, or even fully developed potential rule component (Coglianese, 2004). In practice, it is often difficult to know the extent to which these public comments are incorporated in rules. Most research on public comments has focused more specifically on the role of non-profit and special interest groups in shifting the direction of policy

(Zavestoski & Shulman, 2002). However, inasmuch as the comments or proposals actually generate viable rule components, policy innovation can be created from the bottom-up, with little interaction between the public and private sectors. A modular rulemaking process is not subject to the same limitations on which private sector actors can be involved.

2.21. An Illustrative Context – the Carbon Offset industry

The carbon offset industry provides an illustrative context in which to observe both the more traditional integrated and the more uncommon modular rulemaking processes. Scientific consensus on the role of human activity on increases in greenhouse gas emissions leading to possible catastrophic consequences (Doran & Kendall Zimmerman, 2009; Houghton et al., 2001; Oreskes, 2004; Pielke Jr & Oreskes, 2005), as well as economists' wide agreement on the associated economic impacts requiring government action (Holladay, Horne, & Schwartz, 2009) has motivated innovation in policymaking. The task of reducing greenhouse gas emissions is much more complex than prior market-based cap and trade schemes which covered a limited number of pollution producing sources (Burtraw, Evans, Krupnick, Palmer, & Toth, 2005). The potential for regulation of greenhouse gas emissions is much more expansive and open-ended, and the need for reductions spans all economic sectors, industries, and countries. Moreover, many methods for emission reductions might come from processes that are not yet recognized. Thus, the context of regulatory efforts dealing with climate change is one that requires the formation of many new rules which did not exist previously.

Carbon offsets are an important component of a flexible market-based system for dealing with environmental issues. A carbon offset is a financial instrument that is associated with the *reduction* of emission to the atmosphere of one ton of CO2. Each offset needs to represent an actual reduction in greenhouse gas emissions compared to what would have occurred otherwise in order for the purchasing of carbon offsets to reduce greenhouse gas emissions (Greiner & A. Michaelowa, 2003). The term used to describe this improvement over the 'business-as-usual' scenario is 'additionality.' Other words used often to explain this key concept include: 'real', 'verifiable,' 'permanent' and 'measurable' (M. Schneider, 2009). In a market-based system, a carbon offset can be purchased by another party that has an interest in greenhouse gas emission reduction. Offset buyers have multiple motivations. Some companies buy offsets to meet emission reduction required by regulations. Other individuals or companies buy offsets to voluntarily promote environmental sustainability. Thus, a market for carbon offsets creates an incentive for private sector actors, both non-profit organizations and firms, to search for ways to create greenhouse gas emission reductions that can be sold as carbon offsets. Market forces can help guide the private sector to the most efficient greenhouse gas emission reductions (Grubb, 2003).

Carbon offsets projects date to 1989, when a U.S. electric company paid for a forestry project to offset the emissions associated with a new coal-fired power plant (Brown & Adger, 1994). The basic idea was that it would be more socially, economically and environmentally-efficient to generate emission reductions in Guatemala than to reduce the emissions from the new plant. Carbon offsets achieved much greater global

scale with the ratification in 1997 of the Kyoto Protocol cap-and-trade system by the Kyoto Conference of Parties of the UN Framework Convention on Climate Change (UNFCCC). A total of 190 nation-states have ratified or acceded to the Kyoto Protocol (the USA is a notable exception). Industrialized country firms regulated by the Kyoto Protocol can choose to keep their emissions within the emission allowance (cap), or if they exceed the allowance, they can buy allowances or reductions, measured in tons of CO2, from other regulated firms with excess emission capacity. Allowances can also be purchased from carbon offset projects in developing countries, which are not subject to emissions limits, through the Clean Development Mechanism (CDM). The CDM is by far the largest carbon offset system in the world.

Over 25 carbon offset systems, ranging from regional to national and international scope have been established. Some of these systems are voluntary, while others are associated with a mandatory local or regional cap-and-trade system. (Stockholm Environment Institute, 2011). For example, since the U.S. is not subject to the Kyoto Protocol, various multi-state cap-and-trade systems have been established that allow carbon offsets to be used to meet emission reductions requirements of local governments. Other voluntary cap-and-trade systems seek to prepare for eventual cap-and-trade regulation. For example, the Chicago Climate Exchange was established as a voluntary pilot program to develop a system that might be a platform for a future regulated cap-and-trade system in the U.S. The California Climate Action Registry was established in 2001 by the California state government to provide a voluntary system by which companies could calculate and report their greenhouse gas emissions (“Climate Action

Reserve," 2011). For this paper, I focus on the U.N.'s Clean Development Mechanism (CDM) and California's Climate Action Reserve (CAR). Carbon offsets are called certified emission reductions (or CERs) in the CDM and Climate Reserve Tonnes (or CRTs) in CAR.

Determining ways to reduce greenhouse gas emissions, and then specifying a procedure to define, measure, and monitor these reductions relative to a hypothetical counterfactual (Wara & Victor, 2008) is not always easy. Moreover, emission reductions are not associated with only one industrial context, but span all productive industries. Thus, carbon offsets require innovation in rulemaking. Not only must the rule identify a technical process for greenhouse gas reduction, it must also develop an appropriate process to calculate, compared to a clearly defined counterfactual, how much the project reduced emissions. Below I provide a detailed explanation of how policy innovations are created in the CDM and CAR rulemaking processes.

2.22. The CDM Rulemaking Process

In the CDM rulemaking process, policy innovation comes from the bottom-up. A project design document (PDD), which explains the process of producing, measuring and monitoring emission reductions is required for each project to generate carbon offsets (CER's). Each PDD must follow an approved methodology for quantifying and monitoring the greenhouse gas emission reductions. Approved methodologies, which are 15-90 page documents with detailed procedures and calculations to calculate how many carbon offsets are produced by a project of particular type, are publicly posted on the

UNFCCC website. If there is not an existing methodology that adequately applies to the focal project, a new methodology (a new policy innovation) must be developed to demonstrate the additionality of the reductions provided by their project. The UNFCCC reviews proposed methodologies to ensure that they follow specified guidelines, but generally relies on the private sector to develop policy innovations[1]. Once approved, methodologies become part of the rules for the CDM, which are easily accessible and can be used freely by future CDM projects. Each new methodology that fits into the UNFCCC policy framework is a policy innovation in that it identifies a new way to meet policy objectives of GHG emission reductions.

The CDM rulemaking process involves separate actions from both the policymaker and private sector actors. Each successive rule from the private sector builds up the specific rules for governing the CDM.[2] The CDM process goes beyond typical levels of modularity associated with a regulator soliciting comments on proposed rules from the private sector. Rather, the CDM methodology development process requires the development of fully-formed rules, which are approved, modified, or rejected by the UNFCCC. Therefore, the decision of the scope and direction of innovation is determined by the private sector (through new methodology creation), subject to the approval of the regulatory agency. In this way, the CDM framework is built up incrementally, piece by piece, through private sector innovation applied to CDM policies. In a bottom-up

[1] While the UNFCCC later began developing simplified methodologies for larger projects, the majority of methodologies have started with the private sector.

[2] Except for very minor revisions, new methodologies are required for modifications to an existing CDM methodology.

modular rulemaking process like that of the CDM, the policy innovation process begins with innovative activity from the private sector.

I illustrate with an example. A landfill owner in India discovers that by capping their landfill and capturing the methane, the owner could reduce GHG emissions, and thus create carbon offsets within the CDM framework. If a methodology exists that applies to similar landfill projects, the project owner follows this methodology, most likely with the help of a consultant to correctly develop and monitor the project. The project and methodology development process requires extensive time and expertise, so technical consultants play a major role in helping project owners to develop new methodologies. The consultant can also help arrange financing for the project and interface with the UNFCCC to address any questions or comments that come up in the project review period. The consultant is a carbon offset firm, and the carbon offset industry is the group of firms that develop carbon offset projects.

Alternatively, if the project envisioned by the project owner does not fit within the applicability conditions of any existing methodology, the owner must create a new methodology, complete with very detailed calculations showing how much greenhouse gas would be released to the atmosphere without the proposed project activities (the baseline) and how much GHG would be released with the addition of the project activities. The difference between the baseline and proposed states equals the carbon emission reduction. The methodology also describes how the GHG emission reductions would be monitored over time. Just as technological innovations build on prior technological innovations, new CDM methodology can reference, copy, or imitate parts

of prior approved methodologies, so methodologies do not have to be created from scratch.

2.23. The CAR Rulemaking Process

The rulemaking process in the Climate Action Reserve (CAR) is more top-down. A small number of CAR employees internally screen project types with good potential for development of a protocol (a new rule). They also accept project type submission suggestions from the public. However, they do not necessarily act on these suggestions. Staff (or consultants that they contract) develop an 'issue paper' that seeks to determine if an appropriate protocol can be developed for a particular project type. This determination includes assessment of technical feasibility (whether a performance standard is possible) and market feasibility (whether there are a sufficient number of projects that could use the protocol). If the issue paper indicates that a protocol would be feasible, CAR staff invites a small number of stakeholders, including industry experts, academics, industry associations, non-profit organizations, and governmental bodies to join a working group to draft the protocol (Levin, 2011). The working group meets together periodically to create the protocol draft. CAR strives for full consensus among the members of the working group. However, CAR staff makes the final decision on protocol details when members of the working group disagree. The draft is posted on the CAR website for public comment, and finally presented to the CAR board for approval. Once approved, any project owner or carbon offset firm may use the protocol to generate carbon offsets in the CAR system.

The CAR rulemaking process starts with decisions of the regulatory agency. This differs from the CDM rulemaking process, in which the decision to create policy innovation is made unilaterally by private sector actors. While CAR accepts recommendations regarding potential protocols from the private sector, these recommendations are not formally recognized as part of the protocol formation process, and are thus treated as helpful advice (*Program Manual*, 2010). And even though CAR does accept public comments, the rulemaking process is considered to be mostly done before the public comment period (Levin, 2011).

Moreover, the interaction between the public policymaker (CDM or CAR staff) and private sector actors differs. The rulemaking process integrates the actions of the regulatory agency (CAR staff) and private sector actors (the protocol working group, with representation from various stakeholders). Their rulemaking actions are intertwined together in meetings, negotiations, and consensus-making in the rulemaking process. On the other hand, in the CDM, while the actions of both the public and private sectors is necessary for rulemaking, the interaction between the public and private sectors in creating new CDM methodologies is low.

Below I derive more specific propositions regarding the tradeoffs between integration and modularity in rulemaking. I support my claims with empirical observations from the two rulemaking systems, which I summarize in Table 1 below.

Table 2: Comparison of CDM and CAR Rulemaking Processes

Evidence Supporting Propositions		Clean Development Mechanism (CDM)	Climate Action Reserve (CAR)
	Rulemaking process structure	Modular	Integrated
	Innovation generation comes from:	Bottom-up from individual private sector actors	Top-down from regulatory agency
Prop.1	Policy innovations started	453 methodologies 157 approved methodologies 32 methodologies under review	28 project type submissions 12 approved protocols 3 protocols under development 2 promising issue papers
	Parties involved (per policy)	242 policy innovators (0.9 per policy)	209 policy innovators (17.5 per policy)
	% industry associations	0%	5.7 % (12/209)
	% for-profit firms	80.5% (195/242)	44.4% (93/209)
	% that are non-profits	8.7% (21/242)	11.5% (24/209)
	% governmental bodies	10.7% (26/242)	28.2% (59/209)
Prop.2	% of innovator's founding date $\geq$ 2000	27.7% (65/235)	12.0% (25/209)
Prop. 3a	Distribution Statistics of Rule Effectiveness	Mean (std dev) = 72.6 (299.8) projects Skewness (kurtosis) =7.0 (55.5) projects	Mean (std dev) = 27.4 (49.8) projects Skewness (kurtosis) =2.4 (7.9) projects
Prop. 3b	"Zombie" innovations (approved innovation but diffusion of 0 or 1)	51	0
Prop. 3a	Failed policy innovations	254 methodologies	5 issue papers deemed limited, 2 issue papers waiting

2.3. TRADEOFFS BETWEEN MODULARITY AND INTEGRATION

2.31. Variety in Innovation

The structure of coordination between private and public actors in policy innovation illustrates a trade-off between access to informational variety and avoidance of costly mistakes that is common in many organizational settings (Csaszar, 2012). Modular rulemaking structures allow the development of many different approaches to accomplishing policy objectives. For example, while it was clear from the outset that converting coal-fired plants to alternative energy would be an area that should be included in the details of carbon offset regulation, it is unlikely that some other methods that have been developed would have been identified by a panel of experts.

A modular approach allows a variety of organization types that might be difficult to incorporate in a more integrated policy making structure to create policy innovations. With a modular rulemaking process, both profit-motivated firms and non-profits can develop rule components. Non-profit organizations often have an interest in the public interest and the policies seeking to achieve this public interest. Non-profits can often achieve their private interests by promoting the public interest. Thus, involving non-profit organizations can save a regulatory agency significant costs in time and effort. However, there is rarely complete agreement on what the best way to achieve the public interest is, even among like-minded non-profit groups. In fact, many non-profit organizations, even within the same sector or social movement, have different priorities, which are not always compatible (Zald & J. D McCarthy, 1990). In a modular policy innovation system, non-profit organizations are able to unilaterally create policy modules that are

more closely aligned with their ideals. Thus, a modular rulemaking process generates variety in policy innovation.

On the other hand, the consensus-building process that is typical among a more integrated rulemaking process, like CAR, constrains the number of options considered. Physical and temporal constraints limit the number of people and organizations that can be integrated together in group decision-making. There are only so many people that "come to the table," even if the table is quite large. Indeed, CAR staff limits the working group size to keep the protocol drafting process manageable (Levin, 2011). In uniting various parties in policy innovation, negotiation between multiple parties also tends to narrow quickly to a few alternatives. Thus, the rule making process typically requires compromises, and this means ignoring existing or potential alternatives that might be effective in meeting some of the regulatory objectives. This means that an integrated rulemaking process based on consensus-making is more likely than a modular system to fail to develop a rule, or policy innovation that might be very effective at meeting regulatory objectives.

While an integrated rulemaking process can also access informational variety by soliciting recommendations from the private sector (as CAR does), informal and ad hoc solicitation of recommendations still faces a key information problem. If there is not a clear standard that recommendations must meet in order to merit review, it is hard to know whether policy recommendations from the private sector are feasible. However, it is relatively easy for any one private sector organization to make a recommendation. The regulatory agency must then expend time and effort in reviewing recommendations that

are easily generated by a larger number of private sector actors. In the United States, the American Procedures Act requires regulatory agencies to give notice to the public of proposed rules and provide time for public comment before a final rule is approved and issued (Coglianese, 2004). While this informal rulemaking process can influence a regulator's decisions, public comments are often more philosophical and rhetorical than substantive (Shulman, 2003). The internet lowers the cost for the public to generate comments. However, the reduction in costs of participation can lead to overwhelmed regulatory staff as well as comments with little substantive value.

Since the CDM and CAR are so different in geographic scope and age, it is not possible to empirically test for differences between the two rulemaking systems. However, the performance of the two systems indicates that a modular policy innovation process is better able to generate variety in policy innovation. For example, as shown in Table 1, from inception until the end of 2011, 453 CDM methodologies (policy innovations) applicable to industrial processes and projects from 13 different industrial sectors have been created by 240 consultants, including 23 non-profit organizations and 26 governmental bodies. 69 of these consultants only participated once in creating a new methodology. These statistics demonstrate that the CDM's modular rulemaking process enables widespread access to rulemaking influence.

While a variety of organizations have some influence on CAR rulemaking, CAR has much narrower policy innovation. CAR has a slightly shorter history of operation. CAR began developing a forestry protocol ("Forest Project Protocol Development – Climate Action Reserve," 2011) in 2003, which is the same year that CDM

methodologies were first proposed.[3] Moreover, CAR covers a much smaller economic and geographic region. However, it is the process of narrowing from the top-down, that limits the variety of policy innovations. With a later start date, CAR protocol developers can observe any strengths and deficiencies of the CDM. As shown in Table 1, the rulemaking process has generated only 12 approved protocols and three protocols are under development. While an additional 28 project type submissions and nine issue papers were completed, none of these have been developed into a complete protocol in CAR. Thus, even though CAR allows a bottom-up modular input, the top-down, integrated process of review limits the actual variety.

On the other hand, many of the CDM methodologies would likely not have been foreseen by UNFCCC regulators. For example, even for an outsider, it seems obvious that the CDM needs to develop policy components such as proposed methodology NM0012, entitled 'Wind farm' and NM0016 'Fuel switch from coal to natural gas.' However, such is not the case with proposed CDM methodologies like NM0280, entitled 'Installation of energy free water purifier for safe drinking water application' or NM0056, entitled 'Biogas from alcohol wastewater' or NM0108, entitled 'Biodiesel from oil seeds on Jatropa and Pangamia trees and waste oil.' The creators of these policy components came from different industries and different countries. Seeking to incorporate these innovators into a more typical rulemaking process that integrates

[3] The World Bank and other government entities were exploring possibilities for carbon offsets before the start of the CDM,

together multiple views and opinions of other established stakeholders would significantly increase the costs of producing a similar policy innovation.

Thus, the modularity literature and the history of the CDM and CAR indicate:

Proposition 1*: Modular rulemaking is more likely to generate higher policy innovation variety than integrated rulemaking processes.*

A modular rulemaking system increases access to rulemaking processes for those that typically are not involved in integrated rulemaking processes. Private sector actors that are more powerful and central to an industry typically have greater access to rulemaking (Heinz & Laumann, 1982; Scott, 2008), which is often more integrated than modular. For example, organizations that have either the resources to lobby, the market position to be represented on an industry panel, or the reputation to be represented on a government panel can influence an integrated rulemaking process. A modular rulemaking system does not diminish the access of those that would typically be involved from the private sector in rulemaking. However, modularity in rulemaking allows an unlimited number of private sector actors to be involved in rulemaking. No judgment is required about which organizations are most necessary or appropriate. Thus, modularity tends to increase access for those that that have characteristics that might limit their influence in an integrated system.

Those that have fewer resources, have lower reputation, or are positioned on the industry's periphery tend to benefit from modularity in rulemaking. Among those with

increased access are entrepreneurs. Entrepreneurs play an important role in emerging industries, since emerging industries are often built on technological discontinuities that create competence destroying changes (Tushman & Anderson, 1986). Entrepreneurship research indicates that shifts in regulations create opportunities for new ventures (Eckhardt & Shane, 2003). However, new ventures often would not have access to an integrated rulemaking process. Incumbent firms, non-profit organizations, and other governmental bodies are typically larger and have more resources. Incumbent organizations have been able to build relationships with elected officials as well as regulatory agency staff, and have built a reputation. New ventures, on the other hand, do not have a track record, and are often unknown and illegitimate. This lack of legitimacy is even greater when the policy changes are creating an emerging industry (Aldrich & Fiol, 1994).

Yet the lack of legitimacy and prior history do not hinder new ventures from creating policy innovations in a modular rulemaking process. New venture are quite involved in creating CDM policy modules. For example, as shown in Table 1, 28% of the organizations involved in authoring methodologies in the CDM were founded since 2000. In contrast, even though CAR has a shorter history, 12% involved in the CAR policy innovation process were founded since 2000. In other words, the rate of involvement of new ventures in the CDM's modular rulemaking system is more than twice that of CAR's integrated rulemaking system. These numerical differences vastly underestimate the difference between the influences of new ventures on policy innovation in the two processes. As shown in Table 1, CAR involves many more organizations in creating each

policy innovation. Thus, the contribution of each individual organization on a policy innovation is much less. Moreover, since CAR's development lagged that of the CDM, using the same year to identify new venture policy innovators tends to overestimate the number of new ventures that contribute to the CAR rulemaking process. Based on these arguments and evidence from the CDM and CAR rulemaking systems, I argue:

> ***Proposition 2****: New ventures are more likely to be involved in policy innovation in a modular rulemaking system than an integrated rulemaking system.*

2.32. Costs of Modularity

The organizations that have access to rulemaking processes in a modular rulemaking system that would not in an integrated rulemaking system are likely to be different from those that typically influence policy. While access to influence on an integrated rulemaking system is associated with reputation, market position, and resources, it is also related to organizational knowledge and capabilities. Organizations that have more widely valuable knowledge are more likely to be chosen by a regulator to be involved in integrated rulemaking processes. One way to have widely valuable knowledge is to occupy a more central position in the industry's knowledge structure. Organizations on the periphery of an industry's knowledge are likely to be less similar to the rest of the industry. Yet an organization from the periphery may be able to create a radical policy innovation that changes the current industry by making prior knowledge held by established organizations less useful (Henderson & Clark, 1990). However, just

as with other types of innovations, the likelihood of success of this type of policy innovation is low. Thus, a modular rulemaking process is more likely to involve a private sector actor who will create the next revolutionary policy innovation, as well as involve private sector actors with less useful knowledge.

In a rulemaking system in which policy innovations are public goods, such as in the CDM, incentives to create policy innovations are unclear. If a private sector policy innovator received royalties when the rule that they created was used, there would be a clear incentive for methodology authors to create widely useful policy innovations. However, in the CDM, methodology authors have no such property rights. A methodology author may benefit from increased reputation and legitimacy within the industry by being recognized as a knowledgeable leader within the industry (Dutt, 2011). Both for-profit and non-profit organizations may be concerned with their reputation as a knowledgeable and influential policy innovator. However, in an emerging and uncertain industry, it is difficult for other stakeholders to determine whether a particular rule is more effective than another. Thus, as interviews with project consultants indicate, reputation and legitimacy may be more easily gained by increasing the *number* of rules that an organization creates, rather than the quality of their rules (Dutt, 2011). Consultants that have authored methodologies advertise both the number of methodologies that they have authored, as well as the adoption level a particular methodology. Thus a modular system without property rights for policy innovation may give conflicting incentives that lead to more, but less effective rules

A modular system is likely to struggle with sorting through policy innovations of varying value for three reasons. First, while agency staff is skilled at checking the fit between the rule and regulatory objectives, they are not in the position to know how well rules fit with the needs of industry. Thus, it is difficult for agency staff to recognize if the private sector actors create a rule or standard that cannot be used by other projects. Moreover, regulatory agency staff often unknowingly make changes to proposed methodologies that render the approved methodology less effective or request changes that are infeasible (Dutt, 2011; Koch, 2011)

Second, regulatory agencies must pay more attention to issues of fairness in reviewing components of rules created by private sector actors. Firms jointly producing products are not held to the same standards of 'equality before the law' (Hayek, 1960) that public regulators experience. The need to ensure procedural fairness creates difficulties for a policymaker in review of proposed rules. In effect, a modular rulemaking system makes it difficult for the regulatory agency to single out any proposed rule as of little value to the industry, as long as the component does not actually violate legal or procedural principles. Thus, a modular rulemaking system is likely to fail to reject rule components that are unlikely to be effective.

Thus, in summary, private sector actors who are able to be involved in rulemaking in a modular rulemaking system that would be unable to do so in an integrated rulemaking system are more likely to have less valuable knowledge. Moreover, private sector actors may have incentives to create more, but not necessarily more effective, components of rules. And finally, norms of procedural justice make it difficult for a

policymaker to screen for policy components of little value. Thus, the knowledge that is accessed through a bottom-up modular policy system is likely to produce components with a large variance in subsequent value to the industry.

The reality of this tradeoff is illustrated in the contrast in efficiency between the CDM and CAR. As shown in Table 1, from the 453 methodologies submitted to the CDM for approval, 157 approved methodologies have actually been used by 9045 projects from 87 countries from 2003 to 2011. Due to consolidation and revisions it is difficult to exactly match each approved methodology to one proposed methodology[4]. However, it is clear that CDM methodologies vary in their effectiveness at producing emission reductions in an economical manner. As shown in Table 1, the adoption rate of methodologies is highly skewed, with a two of the methodologies being used in almost half of carbon offset projects. Moreover, 254 (or 56%) of proposed methodologies were withdrawn or subsequently not approved because they did not meet UNFCCC requirements.

Modularity in rulemaking also further explains the existence of 'zombie' CDM methodologies. These CDM methodologies were actually approved by the UNFCCC Executive Board, but were never used by any projects. In other words, they were not found to be effective at matching policy objectives with industrial realities. Of the 157 active approved methodologies at the end of 2011, 51 were 'zombie' methodologies. In fact, the UNFCCC recognized the weaknesses of the bottom-up, modular rulemaking

[4] In fact, the UNFCCC recognized the shortcomings of the bottom-up methodology development process and developed 44 methodologies, some of which were based on previously proposed methodologies in a top-down rulemaking process.

process. In June 2009, the UNFCCC sought comments from the public on reasons for why 94 approved methodologies had been followed by five or fewer validated or registered projects (UNFCCC, 2009).

On the other hand, none of CAR protocols that started the protocol development process have been abandoned. CAR staff has abandoned 25 project submission types, and have declared five CAR issue papers to have a lack of promise for protocol development. However, these potential policy innovations did not fully begin the policy innovation process. Thus, the top-down integrated process, even though it incorporated some levels of modularity, narrowed the policy innovation process to avoid potentially ineffective policy innovations. Thus, I propose:

> ***Proposition 3a****: Modular rulemaking systems are more likely to create policy innovations with higher variance in effectiveness than are integrated rulemaking systems.*
>
> ***Proposition 3b****: Modular rulemaking systems are more likely to produce rules that are ineffective than are integrated rulemaking systems.*

2.4. DISCUSSION

This comparison of the CDM and CAR rulemaking processes has implications for our understanding of the interaction between regulations and firms operating in an industry. First, it appears that modularity in rulemaking tends to increase participation in rulemaking by new ventures. All of the founding dates of each of the project consultants

in each carbon offset system are not available, but it seems plausible that more new ventures involved in rulemaking would lead to more new ventures within the industry. Moreover, modularity in rulemaking may also influence the size and scope of firms within an industry. Modular rulemaking systems that create a variety of rules by which firms can meet regulatory requirements create a greater number of market niches, and correspondingly smaller firms.

As mentioned previously, before the internet, and subsequent changes in organization, modularity in rulemaking would have been difficult to implement. However, as the internet is increasingly used in rulemaking, changes in industrial organization and entrepreneurship patterns may follow, partly due to changes in how firms interact with regulators in rulemaking.

The structure of interaction between the private sector and regulators also has implications for the strategies of private sector actors. For example, social movement organizations may need to alter or create new tactics to fulfill their organizational goals in a modular rulemaking process. Moreover, the level of interdependence between a firm and the regulatory agency in rulemaking alters the costs and benefits for nonmarket strategy. Finally, a modular rulemaking process provides an illustrative context in which to study whether firms that participate in rulemaking perform better.

This paper also has implication for the theory of modularity. Although modularity is a property that can be applied to systems of all types (Schilling, 2000), most of the contexts in which modularity theory in the management literature has been developed are related to interactions between technologies or between for-profit firms co-producing a

product. Modularity in rulemaking concerns the interaction between public and private sector in creating policy. As I have discussed, the norms for interaction between government and private sector affect how a modular system functions. This observation can provide further nuance to extend the usefulness of modularity theory beyond technological domains.

The concept of modularity in rulemaking may also provide practical insight to policymakers. The rulemaking process requires multiple activities and decisions. A regulator may need to control particular parts of the rulemaking process, so completely opening up the entire process of rulemaking for open innovation (Chesbrough, 2003) may not be feasible. However, the rulemaking process can be modularized, and certain components of this process could be opened up to policy innovation by organizations, both for-profit and non-profit, that are interested in creating effective rules in a new industry.

My observations from the CDM indicate potential pitfalls that can be encountered in transferring processes from the realm of technological innovation to rulemaking. For example, an important problem in the CDM has been delays in the methodology approval processes. Limited UN staff has been spread over many proposed methodologies, often with little understanding of which methodologies would best help to increase the number of projects. The propositions that I have developed indicate that policymakers need to access market knowledge to know the value of a particular methodology so that valuable policymaker time can be better allocated to methodologies that will be used more often. One method to access this knowledge would be ‘crowdsourcing,’ in which the wisdom of

masses is mobilized through the internet (Alonso, Rose, & Stewart, 2008). This would provide a way for a larger group of stakeholders to vote on how impactful the methodologies that have been proposed to the UNFCCC might be. In this way, the UNFCCC would be able to access knowledge of a larger variety of private sector actors, and at the same time have a procedure by which to maintain fairness in prioritizing some proposed methodologies over others.

The case study also has several limitations. First, the carbon offsets market is unique and innovative in so many ways that one might wonder whether it is a context that is too idiosyncratic to be informative for future policy structures. Indeed, neither CDM nor CAR is an ideal type. While the general system for rulemaking in the CDM is bottom-up and modular, the UNFCCC created some methodologies in a top-down integrated process. Moreover, the CAR system generally integrates efforts from the public and private sector in a consensus-based process, it benefits from modularity in the project type submission process.

Second, there are many other factors, which may also contribute to the differences in performance that I have highlighted. For example, the CDM operates across multiple institutional contexts, while CAR is focused only on North America. The need for a variety of technical approaches to match these various contexts motivated the CDM's modular rulemaking process, but it also contributes to the variety in rules that I observed. Moreover, the policy objectives of the CDM included not only emission reduction, but also economic development in developing countries. CAR did not have multiple policy objectives. This likely contributes to the differences that I observed. Additional

observation, and perhaps formal modeling, is needed to validate the propositions that I have developed.

2.5. CONCLUSION

Both public and private actors make important contributions in the rulemaking process. However, the way in which a regulator and private sector actors interact in the rulemaking process is similar to the way in which firms interact in producing a new innovation. The interaction typically requires interdependent action in the form of meetings, negotiation, and consensus building. In this typical rulemaking process the actions of the public and private sector are *integrated* in rulemaking. On the other hand, similar to the development of open source software, it is increasingly possible for private sector organizations to create components of regulatory rules that can be inserted in a modular, "plug-and-play" manner that requires little interdependence with the regulator.

I develop the concept of modularity in rulemaking by drawing parallels between the modularity literature and details in the U.N.'s Clean Development Mechanism's rulemaking process. I contrast this process with that of the Climate Action Reserve's more integrated rulemaking process. Modular rulemaking systems broaden access to informational variety from the private sector. They are more likely to benefit from the contributions of organizations that typically do not come to the negotiation table, such as new ventures. However, modular rulemaking systems also tend to produce a higher level of ineffective policies than integrated policy systems, since the additional private sector actors that they attract tend to have less valuable knowledge and unclear incentives to

create less useful rules. These differences in rulemaking systems are likely to influence the emergence and subsequent trajectory of emerging industries in a profound way.

3. PRIVATE BENEFITS OF INSTITUTION BUILDING

3.1 INTRODUCTION

Emerging industries require an infrastructure of institutions that enable economic transactions (Van de Ven & Garud, 1993). The institutions for an emerging industry are the result of actions of multiple institutional actors or institutional entrepreneurs seeking to accomplish their own private interests, as well as the interests of the collective. Firms, politicians, activists, non-profit organizations, technological inventors, trade associations, certifying organizations, and regulators have a multitude of interests related to an industry's emergence (H. Rao, 2004; Sine et al., 2005; Sine & Lee, 2009; Van de Ven & Garud, 1993). These various actors can choose to help build the formal and informal institutions of emerging industries.

Yet, while we know that many private sector actors, with multiple interests, are involved in creating the infrastructure of institutions for emerging industries, we understand less about whether all of these efforts to build the institutions in an emerging industry benefit the firm. Institutions that govern social and economic action can be viewed as an *achieved state* or as an *unfinished process* (Garud, Jain, & Kumaraswamy, 2002). It is clear that favorable institutions, as an *achieved state*, benefit the firm. For example, firms in an industry benefit when government agencies are captured by the interests of industry (Stigler, 1971a) or when norms of legitimacy support a nascent industry (Sine & Lee, 2009). Moreover, non-market strategy research has shown that firms able to influence industry rules and regulative institutions to privilege their

particular interests relative to their competitors will benefit and achieve improved performance (Bonardi et al., 2006). Little existing research empirically examines if and to what degree advocates of new institutional rules are able to appropriate value from the *process* of shaping the institutional infrastructure in nascent industries even if the institutions as an achieved state are not embedded with the firm's own interests.

Specifically, I focus on the role of firm in building an emerging industry's regulative institutions. Despite the ostensible benefits of rules that disproportionately benefit a firm's interests, not all regulative contexts allow firms such a degree of latitude to influence the portion of regulations that directly affects the terms of competition. Yet even in such settings, firms invest substantial time and effort in the *process* of establishing the institutional infrastructure that is required to develop an emerging industry, even when returns to such investments are uncertain.

I propose that the *unfinished process* of institution-building provides important information about firms to their stakeholders. Institution-building efforts are costly and more likely when a firm is capable. Thus, institution-building activities provide an observable signal to potential customers that the firm is capable and committed to the emerging industry. I argue that a firm's involvement with regulators in rulemaking is a type of institutional entrepreneurship. Involvement in creating rules and regulations for an emerging industry creates a visible affiliation with a regulator that creates a signal of leadership within the industry, independent of whether involvement in the *process* leads to *achieved state* that bestows some competitive advantage to the firm. This signal of leadership helps the firm to attract customers amid the uncertainty of industry emergence.

However, I argue that this signal is particularly useful when a firm suffers from characteristics that may signal a deficiency in capability or commitment to the industry.

I investigate the firm performance effects of a firm's involvement with a regulator in the rulemaking process. The context is the emerging carbon offset industry, which is regulated by the United Nations' Clean Development Mechanism (CDM). This industry is crucial in global efforts to deal with climate change by providing a market incentive for clean development in developing countries. The transparency and unique rulemaking process in the CDM allow me to identify the actions of the minority of firms involved in building the rules for producing carbon offsets that enable the industry to flourish. The CDM also allows me to rule out alternative explanations for a relationship between institution-building and subsequent performance.

This paper proceeds as follows. I discuss the need to understand the firm performance effects of the endogenous institution-building process in emerging industries. I argue that institution-building provides a signal that helps a firm to attract customers. I focus on one type of institution-building, firm involvement in rulemaking and use the global carbon offset industry as an ideal setting for studying the relationship between signaling through institution-building and subsequent performance. I develop subsidiary hypotheses to determine whether the value of signaling through institution-building depends on firm characteristics. I detail an empirical strategy and report results that support my hypotheses. I conclude with a discussion of limitations, implications and future directions for research.

3.2 THEORETICAL DEVELOPMENT

Emerging industries can spur economic growth, create jobs, and transform society, yet are often understudied (Forbes & Kirsch, 2011). Understanding industry emergence is important for a variety of reasons for both industry-level and firm-level analysis. Industry emergence constitutes the first phase of industry evolution. Due to path dependent processes, this first period of the industry evolution significantly influences subsequent periods. For example, events in the period of industry emergence may dramatically affect the firms that enter the industry (Aldrich & Ruef, 2006).

Characteristics of competition during the period of industry emergence create pressures for firms that are different than in established industries. Industries in initial periods of emergence may indeed fail before being established. Thus, in addition to competing within the industry, firms also need to help build the industry, since industry failure can lead to firm failure. Thus, firms in emerging industries are more involved in efforts to build or promote the industry.

A key process in industry creation is the building of institutions (Van de Ven, 1993). Institutions guide organizational activities, bring greater levels of predictability, allowing multiple parties to interact in predictable patterns. Institutions include taken-for-granted assumptions (cognitive institutions), norms of appropriateness (normative institutions) and rules and regulations (regulative institutions) (Scott, 2001). Institutions thus exert both enabling and constraining forces that make new patterns of economic exchange possible. Institutions of all types are "rule-like frameworks" that provide stability and order in human interactions (J. W. Meyer & Rowan, 1977; Scott, 2001). Developing the cognitive, normative, and regulative institutions that support an emerging

industry requires effort from multiple actors, including government officials, non-profit organizations, and firms from the private sector. Choosing the extent to which the firm is involved in building the institutions in an emerging industry is an important strategic decision. I focus on these actions in this paper. In particular, my research question is: *Does a firm's involvement in the process of building the institutions in an emerging industry subsequently lead to improved firm performance, even if the content of the institutions does not bestow an individual private benefit? Relatedly, do some firms benefit more or less than others?*

Research in institution theory indicates that institutional frameworks in emerging industries benefit populations of firms that are aligned with or fit within them. In this literature tradition, institutions are assumed to be "social facts," (Zucker, 1987) exogenous or external to the individuals or organizations that are influenced by them. Governments and professions are the major actors in institution-building in this literature (Scott, 2008). Recent research has applied this view to the context of industry emergence. Institutions act upon firms in an emerging industry exogenously(Weber et al., 2008). For example, social norms and taken-for-granted assumptions (normative and cognitive institutions) influence regulations (regulative institutions) and create opportunities in the new alternative energy industry (Meek et al., 2010; Sine et al., 2005). Yet alternative energy power producers play a negligible role in helping to change these institutions (Sine & David, 2003; Sine et al., 2007, 2005; Sine & Lee, 2009).[5] Instead, other actors

[5] Sine and David (2003) indicate, however, that established power companies sought to prevent these opportunities. While Sine and Lee (2009) point out that one wind company entrepreneur was as deeply

with an ideological, technological or personal interest in the founding of the industry are the central actors that build the institutions supporting the emergence of a new industry. These may include hobbyists (H. Rao, 1994), writers and columnists (Weber et al., 2008), activists (Lee, 2009), social movement organizations (Hiatt et al., 2009; Sine & Lee, 2009), standards-based certification organizations (Lee, 2009), trade associations (Hiatt, 2010) and others (Van de Ven & Garud, 1993).

The focus of these institutional accounts is at the field or industry level. Newly conceived taken-for-granted assumptions, norms of appropriateness, or regulations may support the entire industry (Hiatt et al., 2009; H. Rao, 1994; Sine & Lee, 2009) or provide advantages for certain firms that are better aligned with institutional forces (Sine et al., 2005). However, with this focus at the field or population level, less attention is paid to actions of firms. Rather these institutional accounts emphasize that firms that *fit* within the *content* of newly established institutions benefit.

A related literature in institutional entrepreneurship complements institutional approaches to new industry creation by bringing into the foreground the actions of actors and agents with interests in creating, maintaining, or disrupting institutions (DiMaggio, 1988; Lawrence & Suddaby, 2006). Institutional entrepreneurs gather resources to influence the institutional structure to support goals that they value (DiMaggio, 1988). This process of influence requires political and social skills (Garud et al., 2002). Theory-building through in-depth case studies in theoretically rich contexts (often in new

committed to the cause of the environmental movement as the performance of his company, their empirical analysis assumes that institutions affect entrepreneurs, but not vice versa.

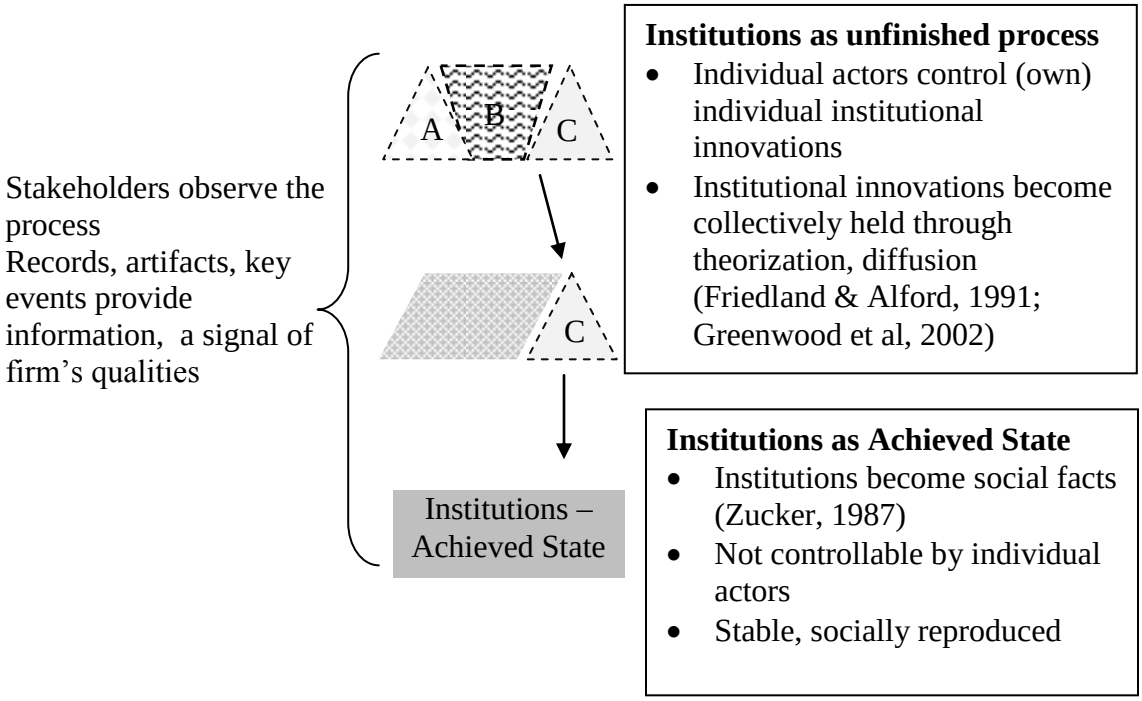
industries) have focused on a more holistic understanding of the activities and processes in molding new institutional orders (Garud et al., 2002; Maguire, Hardy, & Lawrence, 2004). Thus, this literature highlights the fact that institution-building, is in fact an endogenous process. However, from this literature, institutional entrepreneurship appears to be heroic acts of a few social actors given appropriate circumstances, rather than a more common choice made by firms made within an industry.

These two literatures provide complementary views of the process of building institutions, which are depicted in Figure 2. Institutions are seen alternatively as an *unfinished process* or as an *achieved state* (Garud et al., 2002). As an achieved state, institutions are collectively held social facts that are not controllable by individual actors (Zucker, 1987). While the *process* leading to the creation of a particular institutional achieved state is important in an achieved state view of institutions, the assumption is that it is the *content* of institutions that affects firms. Given the same institutional content, the effects on firms would be the same, regardless of the *process* that lead to this institutional *content*. The content of institutions can benefit the entire industry, or may privilege the interests of certain firms. For ease of discussion, I call institutions that benefit the entire industry "collective benefit" institutions and those that privilege the interests of certain firms over other firms in an industry as "individual benefit" institutions.

On the other hand, in the *unfinished process* that leads to more stable institutional orders, individual actors create and exert *control*, or even some level of "ownership" of, institutional innovations. Similar to other innovation processes, institutional entrepreneurs create institutional innovations by re-combining components of existing

institutional structures, or adding something new to them. Typically, multiple actors are involved in this process. However, a few key actors take leadership roles in the key initial stages of the institution-building process (Selznick, 1957). Often using components of prior institutional structures (Lévi-Strauss, 1966), they theorize new taken-for-granted assumptions, norms, and rules and persuade others to adopt them until these institutional innovations become collectively held (Friedland & Alford, 1991). After they are collectively held and accepted, the institutional structure becomes *external* to the actors involved in originally providing the building blocks of the eventual institutional structure. At some later date, the "achieved state" institution may provide some of the building blocks of future institutional innovation processes.

Figure 2: Institution Building as a Process



Research in other domains demonstrates multiple specific ways in which firms are involved in the process of building institutions. Regulatory capture, when firms in an industry overcome weak regulators to privilege the industry's interests relative to the public's interest (Stigler, 1971b), is one example of a way in which firms involved in the process making regulations. On the other hand, corporate political activity research demonstrates that firms in regulated and established industries such as telecom and public utilities can influence agencies to benefit their own individual interests by reducing costs of regulatory compliance or (Bonardi et al., 2006; De Figueiredo Jr & Edwards, 2007). Both regulatory capture and corporate political activity aligns well with an achieved state view of institutions. In both, the *process* of firm involvement precedes the formation of regulations. However, it is the *content* of the regulations that benefits firms. Similarly, technical standards can be embedded in policy so that products from different firms can interact. By serving on a standards committee, it may be more likely that the firm's technology is adopted as the industry standard (Simcoe, 2011). Again, the benefit to firms comes from the achieved state of the standards.

These examples of firm involvement in institution-building demonstrate that institutions contain components that provide "collective benefit" as well as "individual benefit". For example, norms of appropriateness of alternative energy were required for the establishment of an alternative energy industry. These norms provide a collective good to all potential entrants in the industry. On the other hand, institution-building activity may lead to more individual benefit, privileging the interests of some firms over others. It is clear that efforts to establish institutions embedded with individual benefit

components will help a firm. However, it is not clear whether a firm's efforts to establish institutions embedded with collective good components will help a firm, since the firm is unable to exclude others from capturing the same benefits embedded in the institutional content. Unfortunately, it is often unclear ex-ante whether the process of institution-building will result in institutions that contain components that provide a firm individual benefits.

Moreover, the taken-for-granted assumptions, norms of appropriateness, and rules and regulations needed to help an emerging industry grow and thrive often provide collective goods more than individual benefits. For example, industry conferences help to establish exchange relationships between firms, suppliers, and customers. Conferences and trade shows are important in configuring new fields and industries (Lampel & A. Meyer, 2008). Individual firms play a key role in organizing these events, particularly in initial stages. While organizing these events may provide individual benefits to firms, it seems that the principal benefit is to the collective industry. Furthermore, firms may individually, or jointly, seek to promote understanding and acceptance of the industry through media campaigns. For example, the owner of a pawn shop in Las Vegas has starred in a reality show about the pawn shop industry specifically to improve the image of the industry (Lowrey, 2011). Again, this entrepreneur cannot enjoy an increase in the legitimacy of the industry to a greater degree than the rest of the pawn shops in the industry that receive the collective good of increased legitimacy. Finally, key employees of firms in an emerging industry often serve on government technical committees that help to establish regulations, rules, and standards necessary for smooth economic

transactions. While these actions may provide individual benefit to firms involved, much of this work requires costly effort to work out technical and organizational details that cannot be captured by any one firm.

3.21 Considering the Process

The preceding discussion does not consider the degree to which the *process* of institution-building can often be observed by others that are not part of the emerging industry, including firms' stakeholders, such as customers and suppliers. Institution-building actions of firms provide information, and thus signal a firm's characteristics to its stakeholders. The ability to signal a firm's characteristics is particularly valuable in the conditions common in emerging industries because the roles of producers, customers, and suppliers are not yet firmly established in emerging industries (Fligstein, 1997). The notion of substitutable products and services is not yet clear. Information on the identity of competing firms' or characteristics of their products and services is also less available. Moreover, it is difficult to know the length of time that will transpire before an industry emerges (Aldrich & Fiol, 1994; Forbes & Kirsch, 2011), so it is difficult for customers to know which firms will remain in the industry over the long term.

Because there is less information identifying competitors and their prior performance in an emerging industry, and less information regarding the quality of products and services, firms lack some of the traditional tools that they need to attract customers. Involvement in institution-building provides an observable signal to customers of characteristics that customers cannot observe (Spence, 1973). Institution-

building can be an effective signal because it is often visible. For example, serving on standards committees allows firms to gain visibility, which enables them to make future alliances (Rosenkopf et al., 2001) . Moreover, more capable firms are able to be successfully involved in institution-building than other firms, such that not every actor can signal as easily (Connelly, Certo, Ireland, & Reutzel, 2011; Spence, 1973). This is true because institution-building requires skill.

Signaling helps firms to stand out in new market domains, in which past performance information is very limited. Signals can convey a variety of information about a signaler, including status (Podolny, 2005), quality (Spence, 1973) and reputation[6]. For example, Santos and Eisenhardt propose that it is important for firms to signal leadership, or "claim a new and distinct market space and become its 'cognitive referent'" (2009: 649). They signal leadership by focusing customers' attention on specific details or artifacts indicating superiority of the firm. These signals of leadership indicate to customers that the firm is more capable and also more committed, as a leader or a founder of the new industry. Organizing conferences and trade shows, helping to improve the industry's image, and serving on technical committees are just some of the institution-building activities that signal leadership with an emerging industry.

Attracting customers in a new industry is plagued by some of the same problems faced by entrepreneurs seeking to gather other types of resources. Similar to new startups, emerging industries have an uncertain future. The industry may fail to emerge, and thus

[6] Reputation, which is a measure of relative position or ordering (Deephouse & Carter, 2005). Moreover, reputation usually is developed over time, is multidimensional, and is tied to past performance, so it is a particular type of signal.

disappear in the future. Uncertainty makes it difficult for firms to gather resources from a variety of resource providers upon which firms in the emerging industry rely (Zott & Huy, 2007). For example, firms need to hire employees, gain financing, and attract customers. Entrepreneurship research indicates that in conditions of uncertainty firms need to stand out in order to gain these resources. One way in which firms can stand out is to signal to potential resource providers (Podolny & Phillips, 1996). They can do this by affiliating with organizations with more certain characteristics (Hsu, 2006; Stuart, 2000). This type of affiliation-based signaling helps firms obtain financing (Certo, 2003; Gulati & Higgins, 2003; Sanders & Boivie, 2004) gain key human resources (Davila, Foster, & Gupta, 2003), and attract more customers (Kirmani & A. R. Rao, 2000).

Thus, visible institution-building activities that demonstrate a firm's quality and commitment to an industry provide a signal of industry leadership. Institution-building activities that are *observable*, and can be tied to a reputation as an *industry leader* or an industry founder fit within the boundaries of these theoretical arguments. While these institution-building activities are important for both the industry and the firm, they often escape empirical observation. There is typically not a physical record left of the actions. This problem is exacerbated in new industries, in which analysis of the industry by third-party consultants (which is wide-spread in established industries) is not yet established. I focus on just one of these types of institutional entrepreneurship -- involvement in rulemaking. Involvement in rulemaking is just one type of institution creation, which is one of the many types of institutional work (Lawrence & Suddaby, 2006). However, it is

more empirically observable across firms in an industry, which allows for testing whether institution-building activities benefit the firm.

Rules and regulations have clear impacts on firms, and firms can play an important role in forming and molding an industry's rules and regulations. Rules and regulations can be created as legislators legislate or as regulatory agencies prescribe, interpret, or apply legislation through rulemaking (Kerwin, 2011). Government agencies and sub-agencies issue many times more regulations in the rulemaking process than do legislators in the policymaking process (Coglianese, 2004). Firms are not casual observers of the rulemaking process. Rather, they play an important role in forming, maintaining, and altering the rule structure to which they are subjected (Kerwin, 2011). This is particularly true in new industries, in which rules and regulations need to be formed from a blank slate and when the competitive climate is yet to be established. Thus, the rulemaking process, and the involvement of firms in the rulemaking process in new industries, is important in practice.

Interaction with regulators in the rulemaking process also provides a signal to a firm's stakeholders. Generally, regulators can only interact with a certain number of firms in building the rules for an emerging industry. In short, there are only a certain number of seats at rulemaking table, and more capable firms that are more likely to be invited. Thus, involvement in rulemaking is a type of an implicit certification (King et al., 2005) of the firm's quality by the regulator. Moreover, the process of rulemaking often requires considerable expenditures of time and effort. Therefore, it is more likely that firms that are committed to the industry for the long term will benefit from the up-front investment

of time in being involved in the rulemaking process. Thus, involvement in rulemaking is not merely a ceremonial cue, but rather communicates to the firm's stakeholders valuable information (Kirsch, Goldfarb, & Gera, 2009) regarding the firm's quality and commitment to the industry.

Hypothesis 1: Ceteris paribus, a firm's involvement in rulemaking in an emerging industry leads to improved performance.

3.22 A Need for Signaling

The signal to customers related to building the rules of an emerging industry is only one of many pieces of information about the firm's quality and commitment to the industry that customers can assess. Heterogeneity in firm characteristics make the signaling provided by costly involvement in rulemaking more valuable to some firms than others. I discuss two of these characteristics below.

A firm's location provides information indicating the firm's quality to potential stakeholders. A long-standing literature in the country-of-origin effect in marketing has demonstrated the way in which consumers commonly make judgments on firms based on characteristics of a firm's home country (Verlegh & Steenkamp, 1999). For example, products from developing countries are often assumed to be of inferior quality. The reverse is also true. Products and services from locations of high prestige benefit from a halo effect (Han, 1989). Thus, firms from locations of lower status have a greater need for a signal of quality that is provided by involvement in rulemaking. Thus, I argue:

Hypothesis 2: Ceteris paribus, the effect of institution-building on subsequent performance is greater for firms from low status locations in an emerging industry.

Prior organizational history can also indicate a firm's quality and commitment to an emerging industry. Firms entering an emerging industry can be either new entrants or diversifying entrants that come from other (usually related) industries. New entrants typically have fewer resources and less well-developed routines than diversifying entrants (Helfat & Lieberman, 2002). While diversifying entrants operate in at least one other industry, new entrants are fully focused on the emerging industry. Thus, while the fate of the emergence of the industry is important for all entrants, it is even more important for new entrants because their risk of failure is not diversified across industries. Thus, it is clear to their stakeholders that they are committed to the industry. At the same time, the sole focus on the emerging industry indicates that new entrants are also likely to have the skills and capabilities that are suited for the industry. On the other, diversifying entrants have capabilities and routines that have been developed in other industries, and may not be as applicable to the emerging industry. Thus, potential customers may wonder if a diversifying entrant has the capabilities needed for the new industry. For these reasons, all else equal, it is more likely that potential customers see new entrants as capable and committed to the industry. Thus, new entrants have less need for the signal provided by involvement in the process of rulemaking. Therefore, I argue:

Hypothesis 3: Ceteris paribus, the effect of institution-building on subsequent firm performance is diminished (augmented) for new (diversifying) entrants in an emerging industry.

3.3 RESEARCH CONTEXT

The emerging carbon offset industry is an ideal context for observing the potential signaling value of institution-building. Carbon offsets are an important part of international efforts to deal with global warming through the United Nation's Kyoto Protocol. Through the UN's Clean Development Mechanism (CDM), projects that reduce greenhouse gas emissions can be implemented in developing countries. Once these greenhouse gas emission reductions have been calculated, monitored and verified, a United Nation's office, the United Nations Framework Convention on Climate Change (UNFCCC) issues financial instruments, commonly known as carbon offsets. Carbon offsets can be sold to firms in industrialized countries to meet Kyoto Protocol cap-and-trade system requirements. Thus, carbon offsets from the CDM (officially known as "certified emission reductions" or CERs), provide a market incentive to promote the building of an infrastructure based on cleaner technologies (Wara, 2007).

While the UNFCCC ensures the integrity of the CDM, the private sector is responsible for creating the specific rules for carbon offset production. The CDM was designed to be tremendously *flexible* by allowing many different approaches to reducing emissions from a variety of industries and geographical locations. The UNFCCC does not prescribe how to produce emission reductions, but rather verifies that projects generate

"additional" emission reductions, or reductions that are "real", "verifiable," "permanent," and "measurable" (M. Schneider, 2009). The specific rules for how this is done in a particular industrial application are built from the bottom-up, rather than the top-down. The private sector, both for-profit firms and non-profit organizations, can choose to help build this rule system, one component at a time. The components of the CDM rule system are called methodologies. All CDM projects must follow an approved methodology. A methodology specifies exactly what needs to be done in order to generate and measure CER's. A carbon offset firms can choose to only design and develop projects that fit existing methodologies, or can choose to develop new methodologies that allow other types of projects.

I illustrate the carbon offset development process with an example. A factory owner in India discovers that by installing in their factory a new exhaust scrubber that has never been used in India before, he can reduce greenhouse gas emissions from the plant considerably. The owner wants to approach the UNFCCC to generate financial instruments, called carbon offsets, associated with his planned emission reductions that he can sell to companies in Europe. These companies can use the carbon offsets to meet their own Kyoto Protocol requirements. However, the owner needs to quantify the amount of emission reductions and demonstrate to the UNFCCC that these would not have happened without the market incentive provided by the CDM. This requires a lot of calculations and meticulous design so the project owner typically needs the help of a *carbon offset firm*, who designs the project to meet a UNFCCC-approved project design methodology. Carbon offset firms also often help arrange financing for the project and

guide the project through the series of steps required by the UNFCCC to generate carbon offsets. Carbon offset firms can also seek out project owners who may not know about the Kyoto Protocol or the potential to create carbon offsets.

Carbon offset firms can be both new entrants (startups created specifically to produce carbon offsets) and diversifying entrants (firms coming from adjacent industries with relevant knowledge). Diversifying entrants entering the carbon offset industry come from several other related industries, such as consulting services (e.g. management consulting, environmental consulting), energy (power generation), and agriculture. Among the diversifying entrants are also firms that implement projects in their own facilities. This is a type of backwards integration of project consulting activities by firms whose primary business is in another industry.

What is unique about the carbon offset industry is that the private sector (rather than the UNFCCC) develops the rules for project development, called methodologies, from the bottom up. So if no other similar factory emission methodology had been approved, in order to gain UNFCCC approval, the carbon offset firm would have to create a new methodology. If approved by the UNFCCC, the methodology becomes part of the rules of the industry and can be used by any other firm to create carbon offsets. The methodology, which is a 15-130 page rule-based document, includes very detailed calculations and involved counterfactual scenarios to demonstrate that a project produces real and measurable (or "additional") emission reductions that can be monitored over time. Methodologies are the specific components of the CDM rule system. Thus, the rules, or regulative institutions, of the carbon offset industry are built up component by

component, or methodology by methodology, by the private sector. Thus, methodologies generate a *collective good* for the entire industry.

Finally, details of the CDM rulemaking process make it easier to observe the signaling value of involvement in rulemaking. Meticulous UN records allow unprecedented observation of the rulemaking involvement of specific firms as well as their market performance. The CDM rulemaking process makes it easier to eliminate *other potential mechanisms* by which involvement in rulemaking can influence firm performance. First, because the firm that helps to create the methodology receives no royalties or property rights for the methodology development, the firm does not receive a specific *individual benefit* from involvement in the rulemaking process. This creates a good context in which to measure the benefit of involvement in the process of institution-building, independent of the ability to embed regulations with individual private benefits. Interviews with principals at carbon offset firms also indicate that influence on UN agency staff also does not provide firms with *individual benefits*. For example, "private firms cannot directly influence policy making at the international level" (Flues, A. Michaelowa, & K. Michaelowa, 2009). Moreover, one carbon offset producer said: "Relationships with UNFCCC do not matter" (Dutt, 2011). This qualitative information seems to be supported by the quantitative data as well. Surprisingly, only 5.4 percent of the projects submitted to the UNFCCC were submitted by firms that had also authored the methodology that the project followed.

In short, the details of the CDM rulemaking process allow methodology authors to create rules that yield collective goods for the entire industry. However, firms are not

able to embed rules with individual benefits. While this is a unique rulemaking process, it is similar to many other institution-building activities that firms undertake in new industries that I discussed previously. For example, while a firm may derive an *individual benefit* from the *process* of involvement in industry conferences or legitimacy campaigns for an industry, this individual benefit is not embedded in the content of the legitimacy or understanding of the industry. Rather the individual benefit comes from the signal provided by the process of creating collective goods for the entire industry.

Evidence of Signaling in Carbon Offsets

Details from the carbon offset industry indicate that signaling provided by involvement in rulemaking is important. Project owners care about firm quality and commitment to the industry because the choice of a carbon offset firm is important. A project submitted incorrectly may be approved in such a way that it generates much fewer carbon offsets than previously anticipated or requires extensive and unnecessarily costly monitoring that reduces the net return from the carbon offsets. These projects also typically are allowed to generate carbon offsets for 10-30 years. Yet, once approved, it is difficult to revise a project. It is easier to continue with one carbon offset firm that is familiar with the project.

At the same time, a carbon offset firm's quality and commitment to the industry are largely unobservable. The approval process is lengthy, and the actual production of CERs takes several years. Moreover, there is a high degree of variation across industrial contexts, so technological complexity is quite overwhelming. Due to the short history of carbon offset projects, it is very difficult to determine if a particular carbon offset project

is of high quality. Finally, since the carbon offset industry is a service industry, it is impossible for customers to really observe the quality of the service without experiencing it.

On the other hand, methodology authoring is visible to project owners. Each project design document (PDD) must strictly use a document template based on the corresponding methodology. The name of the carbon offset firm that authored the methodology is included on this template. Moreover, the name of the methodology authoring firm is included on the UNFCCC website on the page where potential project participants would look to see the requirements for developing a particular type of carbon offset project.

Methodology authoring, as a type of firm involvement in rulemaking, is a communicative, rather than ceremonial signal (Kirsch et al., 2009). Authoring a methodology that gains approval requires a great deal of technical expertise. It is easier to follow a previously approved methodology, than to develop a new one. Methodology approval times have averaged 305 days, although some methodologies have taken more than two years to be approved. The process is also very uncertain, as the UNFCCC has rejected 254 of the 453 methodologies that have been proposed. Thus, a firm's capability makes it more able to create a signal through rulemaking. Thus, gaining approval for a methodology demonstrates to potential customers (project owners) that the carbon offset firm is capable.

One carbon offset entrepreneur's website attempts to use methodology authorship as a signal of leadership in the carbon offset industry. Project owners, as customers, are

not in a position typically to assess the technical quality of a carbon offset firm. Therefore, the entrepreneur relies on social comparison with other firms to demonstrate leadership in an emerging industry.

> With no methodology, there are no carbon credits. If a company can use one of the 100 or more methodologies out there – everything from industrial gas abatement to landfill gas capture to renewable energy – then it should. But in many cases, projects don't fit neatly into an established methodology, *so deviations, amendments or completely new protocols are required.* Or one registry may have an approved protocol that cannot be used or transferred to another. Carbonomics, having written or co-written more than 10% of all the CDM methodologies, knows more than just about anyone about guiding a company through methodology review and approval. Carbonomics staff has expertise with most of the approved methodologies in the carbon sphere. Even using an existing protocol has its challenges, as many have a dizzying array of formulas, data variables, quality-control procedures, etc. This is where Carbonomics can help (Baruch, 2011)

Actions by firms involved in rulemaking also indicate that industry participants view methodology authorship as an important signal of quality. For example, in one official communication with UNFCCC, an industrial firm that had authored a methodology with the help of a carbon offset firm (PriceWaterhouse Coopers) petitioned to have their company name included on the methodology document template followed by any project using the methodology. They wrote: "Taking into account that Torrent Power Generation Limited (TPGL) has spent a lot of effort (and money) in the drafting of the methodology and as they consider their contribution as very prestigious their name should also be presented in the section 'Sources'" (UNFCCC, 2006). Thus, methodology authoring is viewed as an important signal within the industry.

3.4 METHOD

3.41 Research Context and Data:

Carbon offset firms began submitting projects and proposing methodologies to the UNFCCC in 2003. From 2003 to the end of 2011, and after dropping projects for which carbon offset firm information is missing, 9045 projects from 91 countries have been submitted for approval to the UNFCCC. Project location is skewed to large countries (China, India and Brazil account for a majority of projects, while several countries have less than 20 projects). These projects required $219 billion in investment and are projected to generate more than $25 billion in carbon credits (Fenhann, 2011) . As shown in Table 2 below, the projects are in one of the various stages of the registration process, those that have been registered, and those that have been rejected or withdrawn. Project submission peaked in 2008 subsequently declined and later increased again in 2011, partially due to uncertainty about whether carbon offset projects will continue to be part of the Kyoto Protocol.

Table 3: CDM Projects

Results	2003	2004	2005	2006	2007	2008	2009	2010	2011	Total
In Process	0	1	10	27	134	316	470	839	1992	3,789
Rejected	1	10	70	270	483	422	181	66	1	1,513
Registered	4	48	419	587	828	809	563	422	0	3,743
Total	5	59	499	884	1445	1547	1214	1327	2065	9045

The UNFCCC website provides extensive data on projects including: the date of submission, the approval decision of the UNFCCC, a copy of each project's design document, and a description of other project related information. The UNFCCC website

also has extensive data on each methodology submitted to the UNFCCC. The UN Risoe Center has extracted important details and dates from the project and methodology documentation and made it available in their "CDM Pipeline" data (Fenhann, 2011). There is a date associated with each step in the project development and methodology development processes. The CDM Pipeline spreadsheet lists the project consultant(s) for each project and for each proposed methodology. I aggregate this project-level and methodology-level data to the firm-year level. Some projects have more than one project consultant. For these projects, I aggregate the project to all project consultants.

These data sources contain only project-level data, but no firm-level information. Many of these firms are very small and are located in developing countries, where data coverage is minimal. In most other contexts it would be impossible to identify all of the firms (which are mostly privately held) that enter an emerging industry spanning 91 countries. Project design documents identify the names and contact information for each carbon offset firm. I gathered firm-level data through a combination of searches of the Orbis database and internet searches. In cases where I could not find the needed information online, I use the e-mail and phone numbers listed for most firms on the UNFCCC project documents to get increased coverage.

This quantitative data is supported by interviews with key informants in the carbon offset industry. I attended two carbon offset industry conferences in 2010 and interviewed 40 participants in the industry. These interviews helped to understand the extent to which firms can gain individual benefits from involvement in rulemaking, other than through signaling. My interviews indicate that influence on UNFCCC staff by firms

is not possible. Moreover, my interviews indicate that learning from involvement in rulemaking (another alternative explanation) is unlikely to be significant for the firms involved in the CDM because the level of interaction with the UNFCCC is limited. Moreover, project consultants indicate that the technical expertise of the UNFCCC was sufficiently low that they are not able to predict the response by UNFCCC staff when methodologies are submitted. Thus, they did not learn much in the process.

3.43 Key Variables

Project level data consists of various events related to project development. The carbon offset firm develops a project design document (PDD) demonstrating how the project follows an approved methodology and submits it to the UNFCCC for comment. Then, a UNFCCC-certified validator, who acts like a carbon auditor, reviews the PDD and the project for compliance. If it receives a positive validation, the PDD is then submitted to the UNFCCC for registration. Once registered, a UNFCCC-certified verifier periodically monitors the project as well as the project documentation to ensure that the emission reductions are in fact happening. Only after successful verification are carbon offsets issued.

I measure performance in terms of projects because additional projects represent additional customers. $Log\_Projects_{it}$, is the logged (due to high skew) number of projects that a given project consultant submits to the UNFCCC in a given year. In a robustness analysis, I also run a model with $Projects_{it}$, without logging, and results are very similar.

If multiple firms are involved with one project, I count the project for each firm. As mentioned before, some of these projects are rejected or withdrawn later or are still in the lengthy process of review. My theory focuses on signaling to customers, so project submission is an appropriate measure of performance.[7]

My independent variable is institutional entrepreneurship. Institutional entrepreneurship, $authoring_{it}$, is the number of CDM methodologies authored by the focal consultant up to the $year_t$. Thus, it is the stock, rather than a flow, of institution-building. As shown in Table 3 below, of the 453 methodologies submitted to the UNFCCC from 2003-2011, 189 have been approved or consolidated with other approved methodologies, 254 have been rejected, and 10 were still in the review process by the end of 2011. Because more than one organization (firm, non-profit, or government-controlled organization) can be involved in authoring methodologies, there are 235 organizations (of the 1599 organizations that are involved in the industry) that have helped to propose a methodology. Organizations that proposed a methodology that was later approved totaled 152. And 119 of these organizations were private firms. I choose to use methodology approval (which limits the total number of events to 189) as the independent variable, rather than methodology submission (the full 453 methodologies), because UNFCCC approval provides an important component of the signal to customers. A methodology that is under review or rejected is unlikely to give a clear signal to customers.

[7] A related measure of performance is *CERs*, which is the number of CERs that are associated with these projects. CER yield varies considerably by project, so it is not used as the main dependent variable.

Table 4: Proposed CDM Methodologies

	Year Proposed									
Result	2003	2004	2005	2006	2007	2008	2009	2010	2011	Total
In Process	0	0	0	0	1	1	1	1	6	10
Rejected	16	27	45	42	27	39	41	12	5	254
Approved	17	11	20	25	22	26	19	10	7	157
Consolidated	3	12	11	3	3	0	0	0	0	32
Total	36	50	76	70	53	66	61	23	18	453

Relying on previous research in country-of-origin research, I code developing country firms as low status and industrialized country firms as high status as 1 if the firm's headquarters is in a developing country. Low_status_i is a dichotomous variable proxying the status of the location of the firm. $New\_entrant_i$ is a dichotomous variable coded as 1 if the firm was founded after 2000. New entrants are less than 10 years old throughout the study period. Also, interestingly, governmental or non-profit organizations often perform the same activities, both in methodology authoring and project development, done by for-profit firms. In order to distinguish between organizations with different incentives, I gathered the organization type and founding date for all of the organizations that were listed as contributing to the producing a proposed methodology that was later approved. I identified this information by searches of the Orbis database, company websites, e-mails, and phone calls. I documented the source of each piece of information. When a project consultant is a subsidiary of a larger firm, I use the original founding date of the parent firm to classify the firm as a new or diversifying entrant.

Along with for-profit firms, governmental institutions and non-profit organizations help to create the rules of the carbon offset industry, as well as develop

projects in the industry. I measure performance in terms of projects in a given year. It is clear that many non-profit organizations and government institutions are involved in the industry to promote the industry sufficiently that other private firms will enter. Because their interests are not necessarily promoted by developing more projects, I assume that the arguments that I have made regarding institution-building's effect on performance will not apply to these organizations. Thus, I drop non-profit organizations and governmental institutions from the analysis.

I also include various control variables. Projects are more likely in some industrial sectors and in some countries than others. I proxy the propensity in a given year for carbon offsets to be produced in a particular region with $region\_projects_{it}$, which is the total number of carbon offset projects submitted in the region in which the firm operates. If the firm operates in multiple regions, I use a weighted average of the regions in which the firm operates. Projects can be developed in a variety of industrial sectors. Based on sector identifiers provided by the UNFCCC, I have divided CDM projects into ten main industrial sectors. Renewable energy (e.g. hydro and wind power projects), improvement of manufacturing processes, and landfill and methane capture projects account for the vast majority of projects. Similarly, I proxy the propensity in a given year for carbon offsets to be produced in a particular industrial sector with $sector\_projects_{it}$, which is the total number of carbon offset projects submitted in the sector in which the firm operates. If the firm operates in multiple sectors, I use a weighted average of the sectors in which the firm operates. I also include the number of sectors in which a firm operated in the prior two years (a firm often does not submit projects every year). I label this variable as

sector_scope$_{it}$. [8] The main variables are displayed in the correlation table in Table 4, below.

[8] I also tried to add a measure of methodology complexity, which is likely to affect whether customers attribute high quality to the methodology author. I code approved methodologies with the dichotomous variable, *nmsl*, which is equal to 1 if the methodology is a small-scale methodology. UNFCCC requirements are reduced for small-scale methodologies. This measure seems to be noisy.

Table 5: Institution Builders Descriptive Statistics and Correlations

Variable	Mean	S.D.	Min	Max	1	2	3	4	5	6	7	8
1 Firm's log_projects	-1.17	1.66	-2.3	4.61								
2 Authoring	0.18	0.76	0	13	0.23							
3 Sector_projects	2.76	3.69	0	14.8	-0.13	-0.11						
4 Region_projects	1.56	1.85	0	9.85	-0.15	-0.12	0.55					
5 Sector_scope(lagged)	0.64	1.01	0	8	0.49	0.43	0.04	0.03				
6 Local_HQ	0.67	0.47	0	1	-0.03	-0.16	0.14	0.22	-0.04			
7 New_entrant	0.27	0.45	0	1	0.24	0	0.03	0.06	0.18	-0.04		
8 Local_HQ*Authoring(lagged)	0.06	0.37	0	7	0.09	0.46	-0.06	-0.08	0.25	0.12	-0.02	
9 New_Entrant*Authoring(lagged)	0.05	0.4	0	9	0.12	0.51	-0.05	-0.04	0.23	-0.09	0.19	0.12

3.45 Empirical Strategy

I estimate the relationship between institution building and subsequent performance. Methodology authorship is a choice, and thus some firms may be more likely to author methodologies than others. For example, resource endowments and capabilities make some firms more able to build institutions as well as perform better. These unobservable firm characteristics, which I cannot satisfactorily proxy, could be omitted variables that bias coefficient estimates, since they can influence both the choice of institutional entrepreneurship as well as performance. I use dynamic panel estimation and the Arellano-Bond estimator to overcome this problem of endogeneity. Dynamic panel estimation uses lags of prior year performance and other independent variables as an instrument for the prior year's performance. I use the two-step procedure and use lags of three years and deeper for creating the set of instruments.

3.5. RESULTS

Table 5 shows results using the Arellano-Bond Dynamic Panel analysis. Notice that the firm-year is the level of measurement, so the total number of firms is 749 (5136 firm-years) in models 1-3 and 576 (3932 firm-years) in model 3 due to increased missing data for the *new_entrant* variable. Notice that time-invariant firm-level variables (along with other time-invariant endogenous firm characteristics) drop out as main effect in a dynamic panel analysis. Therefore, they only enter when interacted with other time-varying variables. I provide several models to better assess the stability of the model as well as understand the effect of various variables on firm performance.

Table 6: Institution Builders Results

Dynamic Panel Models of Logged Project Number

Version Jan 20	Model 1	Model 2	Model 3	Model 4
Variables	**Log(projects)**	**Log(projects)**	**Log(projects)**	**Log(projects)**
L.Firm's log_projects	0.888***	0.712***	0.740***	0.800***
	(0.07)	(0.03)	(0.03)	(0.02)
year== 2004	-0.166*	-0.181**	-0.150**	-0.05
	(0.07)	(0.06)	(0.05)	(0.05)
year== 2005	0.05	0.04	0.090+	0.313***
	(0.07)	(0.06)	(0.05)	(0.05)
year== 2006	0.03	0.03	0.05	0.249***
	(0.07)	(0.07)	(0.06)	(0.05)
year== 2007	0.05	0.09	0.085+	0.180***
	-0.07	-0.06	-0.05	-0.05
year== 2008	-0.05	0.01	0.04	0.215***
	(0.08)	(0.06)	(0.05)	(0.05)
year== 2009	-0.251***	-0.208***	-0.160**	-0.174***
	(0.08)	(0.06)	(0.05)	(0.04)
year== 2010	-0.180*	-0.147*	-0.106+	-0.04
	(0.07)	(0.07)	(0.06)	(0.04)
Sector_projects	0.029***	0.033***	0.033***	0.030***
	(0.01)	(0.01)	(0.01)	(0.01)
Region_projects	0.02	0.027*	0.032*	0.00
	(0.02)	(0.01)	(0.01)	(0.02)
Sector_scope(lagged)	-0.05	0.093*	0.05	0.063**
	(0.09)	(0.05)	(0.04)	(0.02)
Authoring		0.060**	0.051**	0.026+
		(0.02)	(0.02)	(0.01)
Low_status*Authoring(lagged)			0.035**	0.020+
			(0.01)	(0.01)
New_Entrant*Authoring(lagged)				-0.030*
				(0.01)
Constant	(0.06)	-0.459***	-0.435***	-0.375***
	(0.18)	(0.10)	(0.09)	(0.07)
N	5356.00	5316.00	5316.00	3932.00

Standard errors in parentheses

+ significant at 10%;* significant at 5%; ** significant at 1%; *** significant at 0.1%

Model 1shows a baseline model with only control variables, including lagged *sector_scope*. Model 2 adds lagged methodology authorship (*authoring*). In model 3, I

add an interaction (*low_status*authoring (lagged)*) indicating if an author (in the prior year) is headquartered in a developing country. In model 4, I add an interaction (*New_Entrant*Authoring(lagged)*) indicating if an author (in the prior) was a new entrant.

This analysis indicates the following. First, the main effect of methodology authoring on subsequent performance is significant in all of the models. Thus, I find statistical support for Hypothesis 1. However, the effect is modest. Authoring a methodology in prior years is associated with 3% more projects submitted. Since this dynamic panel analysis does not compare across firms, but rather tests deviations over time from firm averages. Thus, authoring a methodology provides a small increase of 3% more projects. Similarly, Hypothesis 2 is also supported. Developing country firms benefit more from methodology authoring than industrialized country firms. But again the effect is modest. Developing country firms that author submit 2% more projects in the subsequent year than otherwise predicted. Finally, I find that new ventures benefit more from methodology authoring (Hypothesis 3). The effect is also modest. New entrants that author submit 3% fewer projects in the subsequent year than otherwise predicted.

3.6 DISCUSSION

This analysis indicate that firms can individually benefit from the process of institution-building process in emerging industries, even when they are unable to embed individual interests in the institutions that they build. Observations in the carbon offset industry as well as this empirical analysis support the theory that a firm's institution-building activities (measured here as involvement in rulemaking) provides a signal to

customers. Rather than trying to fit in to existing institutions, firms try to stand out as leaders in an emerging industry by being known as a firm that helped to build new industry's rules.

Involvement in rulemaking is only one type of institution-building in emerging industries that provides a credible signal to the firm's stakeholders. The signaling value of institution-building could be explored in important activities necessary for industry emergence, including organizing of industry conferences, serving on government advisory panels, and industry legitimating campaigns. Each of these activities is visible and the firm capabilities and commitment to the industry reduce the cost of performing them. They are also likely to build institutions embedded with collective goods, rather than individual benefits.

I contribute to our knowledge of new industry creation by gathering unique data on the entire population of firms in the emerging carbon offset industry. I am able to overcome survivor bias from which many entrepreneurship studies suffer (Aldrich & Fiol, 1994; Forbes & Kirsch, 2011). Moreover, this is a context that is theoretically insightful for the relationship between firms and regulators because of the structure of rulemaking in the CDM, which allows me to identify who is involved in rulemaking as well as the specific type of institution-building engaged in by individual firms, non-profits and other governmental organizations.

I also provide specific insights to non-market strategy research. In addition to explanations based on regulatory capture or property rights, the signal of leadership associated with involvement in rulemaking can be important for firms. I am not able to test in this context which factor is more important, but these results indicate that even the

building of *collective benefit* (rather than embedding institutions with individual benefits) can benefit the firm through the signal that it provides to stakeholders.

Finally, from a practical standpoint, the insights from the carbon offset industry are important for understanding public and private efforts to create market-based approaches to deal with significant social problems. The carbon offsets market is the most developed of these markets, but other similar markets are beginning for water, biodiversity, and other social goods (OECD, 2004). This study helps private sector actors to know better whether their actions to help create rules for these types of market will help to improve their performance.

The study currently has several empirical limitations. One limitation is that I observe a relatively small number (211 approved methodologies across nine years), and only one type of institutional entrepreneurship actions by firms. In reality, there are multiple types of actions that a firm can take to help build an emerging industry's rules. These vary in their transparency and impact on subsequent firm performance. These include over 400 actions by the private sector to revise existing methodologies. Rather than submit an entirely new methodology, carbon offset firms can petition to revise or clarify an existing methodology that covers their project type. Except for very minor revisions, new methodologies are required for any incremental innovation on an existing methodology. In some cases, methodology revisions can take as much effort as approval of a new methodology. Similar to the creation of new methodologies, the proposal of a revision, the date of the proposal, and whether the revision was approved by the UNFCCC are all observable and may be useful for further analysis.

In addition, carbon offset firms, non-profit organizations, and trade associations have made over 600 comments during public commenting periods in which the UNFCCC solicited recommendations for methodology rules. Public comments are an important part of the informal rulemaking process (Kerwin, 2011). The signal provided by public commenting is likely to be weaker; since the cost of commenting is minimal, there is minimal screening of public comments, and it is generally not possible to determine if the UNFCCC heeded the comment. Nevertheless, analysis of these comments might provide a more complete picture of how rules and regulations are built in an emerging industry.

3.7 CONCLUSION

Institutions are needed in order for an emerging industry to emerge and thrive. Firms play an important role in helping to build these institutions. Institutions may provide collective goods to the entire industry, and they may also provide individual benefits to specific firms. Prior research has shown that firms that are able to embed institutions with individual benefits are able to perform better. However, much less is known about whether a firm will individually benefit from helping to establish the infrastructure of taken-for-granted assumptions, norms of appropriateness, and rules and regulations that collectively benefit the entire industry. I have proposed that firms benefit from involvement in the *process*, even if the *content* of institutions does not privilege their interests over their competitors. In emerging industries, firms can *stand out* from the rest of the firms in the industry by sending signals of leadership to their stakeholders.

There are many visible institution-building activities that can credibly signal the firm's quality and commitment to emerging industry. In this study, I have highlighted just

one empirically observable institutional entrepreneurship activity, specifically visible involvement in the creation of regulative institutions for the emerging carbon offset industry. These detailed industry observations and empirical results indicate that involvement in rulemaking provides a signal that improves subsequent firm performance. Moreover, some firms benefit more from this signal than others. Firms from low status locations and diversifying entrants may be viewed as having lower quality or less commitment to the industry. Thus, by helping to build the institutions for an emerging industry, they can overcome this perception. Thus, institution-building for the collective benefit can yield a strategic benefit for firms involved in the process of building an emerging industry's institutions.

4. SPILLOVER EFFECTS FROM INSTITUTION-BUILDING

4.1 INTRODUCTION

A key process in industry creation is the building of institutions (Van de Ven, 1993). Institutions guide organizational activities, bring greater levels of predictability, allowing multiple parties to interact in predictable patterns. Scott classifies institutions as cognitive (taken-for-granted assumptions), normative (norms of appropriateness), and regulative (rules and regulations) (Scott, 2001). Institutions enable and constrain and provide stability and order to all facets of life, including patterns of economic exchange (J. W. Meyer & Rowan, 1977; Scott, 2001).

Developing the cognitive, normative, and regulative institutions that support an emerging industry requires effort from multiple actors. These actors include government officials, non-profit organizations, trade associations , social movement organizations, hobbyists, activists, inventors, and firms from the private sector hobbyists, activists, social movement organizations (Hiatt, 2010; Hiatt et al., 2009; Lee, 2009; H. Rao, 1994; Sine & Lee, 2009; Van de Ven & Garud, 1993). The changes in institutions caused by these actors create entrepreneurial opportunities (Eckhardt & Shane, 2003; Hiatt, 2010). Prior research has demonstrated that institutional change creates opportunities for whole populations of firms.

However, institutional change and industry creation do not happen instantaneously. Rather the process of changing or building institutions may endure over an extended period of time, as discussed in Chapter 3. During this institution building period, institutions are not yet social facts external to the actors involved in creating them (Zucker, 1987). Rather, during this period of institution building, institutional innovations

are directly linked to the institutional entrepreneurs that created them. Moreover, during this institution building period, the effects of institutions on organizations is not necessarily uniform. This study seeks to test whether there are spillover effects on those proximate to institutional entrepreneurs, and whether characteristics of locations that may moderate this effect.

This paper proceeds as follows. I discuss the institution building process related to the emergence of new industries. I argue that during this process, institution building creates spillover effects. I develop subsidiary hypotheses to determine the extent to which the actions of other institutional actors moderate this spillover effects. I detail an empirical strategy and report results that indicate that the actions of nearby institutional actors affects the spillover effects from institution building. I conclude with a discussion of limitations, implications and future directions for research.

4.2 THEORETICAL DEVELOPMENT

Institutions are tied to a particular location through the individuals or organizations that share common taken for granted assumptions, norms, and rules. Regulative institutions, which are enforced through coercion (Scott, 2001), can only be enforced within the reach of those with coercive power. For example, legal requirements are bounded by political jurisdictions. Likewise, norms of appropriateness and taken-for-granted assumptions differ across groups of people with shared culture or values. For this reason, institutional analyses of a quantitative nature often find evidence for the effect of institutions by comparing *across* geographic locations with the assumption that institutions are *different*. For example, Sine and Lee (2009) find that U.S. states with

stronger environmental movement organizations, tend to pass more regulatory policies, which in turn helped the alternative energy industry to grow within the state. Thus, environmental groups provide *spillover benefits* to entrepreneurs within the limits of the institutions that they help to create. The assumption is that different states have different institutions, which are necessary for the alternative energy industry to emerge.

The assumption of homogeneity of effect of institutions within an institutional field is also evident in institutional diffusion research. As institutional fields influence each other, institutions diffuse from one location to another (Lee, 2009). This diffusion process is mediated by institutional actors. For example, in the organic food industry, standards based organizations transmitted, modified, or augmented regulations between U.S. states (Lee, 2009). Thus, it is clear that the institution building process does not proceed at the same pace in all locations. Rather, institutional entrepreneurs act in some institutional fields in advance of other fields, creating opportunities in some locations before others.

Thus, prior institutional research explains how institutions can create differences in entrepreneurial opportunities *between* geographic domains because institutions vary between the locations. This makes sense when institutions have become an 'achieved state' (Garud & Kumaraswamy, 2002) and are considered to be social facts that are exterior to the individual actors on which they exert influence (Zucker, 1987). At this point, institutions bestow predictability to an entire institutional field. However, in the *process* leading to this point, it is not clear that the actions of institutional entrepreneurs

have uniform effects on all organizations *within* an institutional field. Their actions may have heterogeneous spillover benefits.

Institutions, like other social structures, are not created instantly or out of nothing. Instead, as shown in Figure 2, new institutions are pieced together from bits and pieces of existing institutions, along with entirely new pieces, to create new institutional innovations. Thus, prior institutions provide the seedbed for the creation of new institutions. Sometimes this process evolves seemingly autonomously. However, the work of institutional entrepreneurs often plays a very important role. The institutional work of past generations may serve to help or hinder the institutional work of future institutional entrepreneurs. And since there are a variety of actors often involved in this process, the *prior* institutional work of *one* group of actors influences the institutional work of *other* institutional actors. Such was the case in the alternative energy industry as the efforts of social movement organizations to establish norms and acceptance for alternative energy led to more favorable regulations created by legislators (Sine & Lee, 2009).

As discussed in Chapter 3, a firm's involvement in institution-building provides an observable signal to customers of characteristics that customers cannot observe (Podolny, 2005). Institution-building can provide a signal of leadership, demonstrating the quality of the firm and the firm's commitment to the industry. In effect, a firm is raising a flag, which not all firms can raise, in the process of institution building. However, the signaling provided by institution building not only indicates firm

characteristics, but also characteristics of others that are also likely to be involved in helping in the institution building process.

Before institutions become social facts, and accepted as external to the actors involved in creating them, institutions have to be developed, theorized, and promoted by institutional entrepreneurs. As shown in Figure 2, there are many individuals and organizations that can observe this institution-building process. However, there are often also many others involved in the process of institution building.

While theorization of new institutional frameworks can be a unilateral action, an institutional entrepreneur needs to gain support of other institutional actors to be successful. Institutions are, by definition, collectively held. Thus, even though an institutional entrepreneurs leads out, he or she needs to be supported by others. Thus, visible actions of institutional entrepreneurship provide a signal of support indicating support from other actors surrounding the institutional entrepreneur.

This signal is particularly important for entrepreneurs considering entering an emerging industry. Emerging industries are uncertain, and the lack of established institutions present a hazard for potential entrants (Aldrich & Fiol, 1994). However, indication of support from local environment provides information that helps to reduce uncertainty for potential entrants. Thus, the institution building activities of institutional entrepreneurs spill over to other firms in the industry by helping to direct locational choices of entrants within the industry.

Thus, I argue:

H1a: *Ceteris paribus, a firm's institution-building has positive spillover effects on subsequent growth in an emerging industry in the location of the institution-building.*

A firm's involvement in rulemaking indicates multiple types of information to multiple different audiences. I have focused on how potential entrants interpret these institution-building activities. I have argued above that since institution-building usually requires the support of multiple institutional actors, an institution building event indicates the presence of other supportive institutional actors. However, institution-building by a firm also provides a clear signal that the presence of competitor. Thus, institution building may also send a signal of competition. Just as certain research and development disclosure patterns, patenting actions, and intellectual property litigation actions can post 'keep out' signs to potential competitors (Clarkson & Toh, 2010; James, 2011), institution building can also provide a deterrence to potential entrants. These institution-building activities indicate that a capable firm is present, and moreover, that the firm is likely to have the support of other local institutional actors. Thus, a firm's involvement in institution-building can also send a deterrence signal to potential entrants. Depending on the details of the institutional setting, this negative signal can overpower the positive signal of support from other institutional actors. Thus, I argue:

H1a: *Ceteris paribus, a firm's institution-building has positive spillover effects on subsequent growth in an emerging industry in the location of the institution-building.*

If institution-building indicates support from local institutional actors, then the characteristics and specific actions of these actors should affect the strength of the signal of institution-building. As stated previously, the institutionalization process involves various institutional actors and builds on prior institutional frameworks. These frameworks can also overlap, such that the institutions built by one institutional actor can interact with those built by others. One way in which this can happen is when institutions are defined at various levels. For example, while US Federal law covers the entire US, state law applies to particular states, and municipal laws apply only to certain municipalities. The same is also true for cognitive and normative institutions. For example, shared understandings of the appropriate environmental impact of business vary both within and between U.S. states.

That many different individuals and organizations play a key role in establishing an infrastructure for an industry is not a new argument. Van de Ven and Garud (1993) demonstrated that many actors contributed to the cochlear implant industry, and that these actors contributed more at different periods of time. Moreover, Van de Ven (1993) proposed that the prior organizational activity to build an infrastructure for innovation would increase the effectiveness of subsequent activity. Due to data limitations, the influence of prior institution building by one actor on the effects of the institution building by another actor has not been tested.

While institution-building provides a signal of an increased likelihood that there are other institutional actors that are supportive of the industry, prior institution building activity by other institutional actors indicates consistency of support over a longer period

of time. Actions from multiple institutional actors provide a stronger signal of support among institutional actors. Moreover, prior institutional work that is favorable to the industry not only demonstrates support, but also indicates *consistency* in the location of the institution-building. Consistency demonstrates the credible commitment (Fabrizio, 2012) that is important in reducing the uncertainty facing potential entrants in the emerging industry. Thus, I argue:

- ***H2:*** *Ceteris paribus, prior institution-building activities from proximate institutional actors will positively moderate the spillover effects of a firm's involvement in rulemaking on the growth of an emerging industry in that country.*

While actions of institutional entrepreneurship that support the emerging industry by other institutional actors provide a signal of additional support, the degree to which these institutional actors' efforts are beneficial to the industry depends on organizational characteristics. Institutional actors also vary in their capabilities. Some social movement organizations are more capable of mobilizing resources (John D McCarthy & Wolfson, 1996). Some governments are more capable of crafting effective policy (Kaufmann, Kraay, & Mastruzzi, 2010). These capabilities matter because they help institutional actors to be more effective in their institution building. If some of the local institutional actors are more capable of giving greater help and support, institution-building activities provide a more powerful signal that not only is there local support for the industry, but that this support will be effective. Thus, I argue:

H3: *Ceteris paribus, the capabilities of local institutional actors will positively moderate the spillover effects of a firm's involvement in rulemaking on the growth of an emerging industry in that country.*

4.3 RESEARCH CONTEXT

The Regulated Carbon Offset Industry

These hypotheses are tested in the emerging carbon offset industry connected with the UN's Clean Development Mechanism (CDM). An overview of the major players and structure of this industry are explained in the prior chapter. This is an ideal context for testing the extent to which institution-building in a certain location affects growth of the industry in that location, as explained below.

Growth of the CDM in particular countries is important to various actors. The CDM creates a unique market opportunity for emerging and developing countries. The CDM allows carbon offset projects to be developed in any developing or emerging country that has signed the Kyoto Protocol, but is not subject to emission caps. These 152 countries are labeled as non-Annex 1 countries (UNFCCC, 2012).CDM projects can only be based in non-Annex 1 countries. If projects can be identified that follow the guidelines of the UNFCCC, money from the sale of CERs can be directed to the country. Moreover, these projects often result in the transfer of technology from more developed countries (Haites, Duan, & Seres, 2006). Thus, it is in the economic interest of each country's

government officials to grow the carbon offset industry in their country to gain more CDM projects.

It is also in the interest of UN officials to make the carbon offset industry grow broadly across many countries. The future of UN efforts to deal with climate change depends on consensus among many different countries. If the CDM brings development and capital to a country, its officials are more likely to favor a continuance of the CDM. Some countries, most notably in Africa, have not seen the carbon offset industry grow significantly. This has been an important concern for the UNFCCC (UNFCCC, 2007).

As discussed in Chapters 2 and 3, the CDM also provides a context in institution building is an important and measurable event. As mentioned previously, the regulative institutions of the CDM are built through the creation of new methodologies. Thus, methodology development is a specific type of *institution-building*. Each new methodology allows projects with different characteristics to be developed. As mentioned before, the UNFCCC allows the private sector to develop the majority of methodologies. While a methodology can be used to develop a carbon offset project in any country within the CDM, the methodology must be developed in a particular location. Thus, while institutional entrepreneurs help to build institutions that apply to the whole industry, this institution-building activity may have spillover effects on the growth in the local industry.

Moreover, there are clearly various other characteristics of locations *within* an institutional field that cause heterogeneity of effects of institution-building. One of these that I have identified is other institutional actors. A key institutional actor in each country

is the country's Designated National Authority (DNA). Before submitting a project to the UNFCCC, any proposed project must receive a letter of approval (LOA) from the DNA in the country where a project is based. Thus, country officials have to establish a DNA in order for any project to be developed within the country.

While the UNFCCC holds the authority for the CDM, it grants to the DNA a level of regulatory oversight on projects within a country through the LOA. However, in practice, that oversight is limited (Muller, 2007). According to UNFCCC requirements, the LOA must simply state that the country has signed the Kyoto Protocol, and that the project meets the sustainability goals for the country. Thus, the LOA can be as short as a few sentences. So while the LOA is a required to propose a project to the UNFCCC, it is not a factor in determining whether the project is approved. Because each country's DNA determines the criteria that will apply to receive an LOA and because CDM projects bring investment to the country, the DNA has little incentive to deny CDM projects. The letter of approval does not necessarily mean that a project will be approved, since all projects submitted to the UNFCCC have letters of approval, and the rejection rate is high.

A substantial amount of research in energy and climate policy focusing on how to improve the functioning of the CDM indicates importance of the role of the DNA. For many countries, the potential functions of a DNA have not been performed previously. Energy policy researchers have identified a need for capacity-building at the national level, but more specifically within DNAs (A. Michaelowa, 2003; Nondek & Niederberger, 2004). Part of the needed capacity-building is efficient project review. Because CDM projects often require significant capital investment, the speed with which

the DNA office reviews a project influences the profitability of the project. While the DNA has little incentive to reject projects, the review process may take considerable time when staff introduces bureaucratic procedures that transferred from other local governmental functions. Moreover, the DNA's review process, if aligned well with the UNFCCC requirements may help identify issues with the project before submission to the UNFCCC. Thus, the DNA must deal with a tension of providing some regulatory oversight in an efficient manner.

The DNA also plays a promotional role (Lokey, 2009). DNA's help to overcome lack of understanding of the CDM among the country's firms. In addition, DNA's often promote the potential for CDM projects within the country by organizing information sessions that help project owners and project consultants (carbon offset firms) to make connections. DNA's may also identify potential project types that might be especially suited for the focal country. The DNA also helps to legitimize carbon offsets within the country, which helps shield those involved in a CDM project from criticism from environmental groups that do not favor the idea of carbon offsets.

Due to both their regulatory and promotional roles, DNA's also play a very important role in the *institution-building process*. DNA's may help to identify potential project types for which UNFCCC methodologies do not yet exist, and which may increase the number of carbon offset projects in the country. Methodology creation requires a higher level of technical expertise. The DNA can act as a focal point for identifying knowledgeable actors, such as university academics, government experts, and private sector actors that are needed in order to develop projects or new methodologies.

Thus, the DNA is an important institutional actor that exerts an effect on institution-building in the carbon offset industry. While the DNA's actions only specifically apply to their own country, the DNA affects the extent to which private sector actors are able to help build the institutions of the CDM through local methodology authorship.

4.4 METHOD

4.41 Data:

As discussed in the prior chapter, detailed data on the development of all methodologies and projects was obtained from the "CDM Pipeline" data that the UN Risoe Center compiles from the UNFCCC website (Fenhann, 2011). I aggregate to the country-year level (in Chapter 3 I aggregate the same project data to the firm level). As mentioned below, data for other variables is collected from various public data sources. This quantitative data is supported by interviews with key informants in the carbon offset industry as well as other archival data

4.43 Key Variables

Independent Variables

My independent variable is institutional building. Institution building, $authoring_{it}$, is the number of CDM methodologies authored in $country_i$ up to the $year_t$. Thus, it is the stock , rather than a flow, of institution-building. Each methodology must be developed

with a particular project. I do not use the country of origin of the organization(s) responsible for creating the methodology (the focus of the prior chapter). Rather, I record the country where the actual project associated with the methodology is located because I am seeking to measure local spillovers from an institution-building event (methodology authorship). As shown in Table 2 previously, of the 453 methodologies submitted to the UNFCCC from 2003-2011, 189 have been approved or consolidated with other approved methodologies. I use methodology approval (which limits the total number of events to 189) as the independent variable, rather than methodology submission (the full 453 methodologies), because it is the UNFCCC approval that changes the regulative institutions of the CDM.

I also add two variables that describe a country's Designated National Authority (DNA), a key institutional actor in the CDM, as discussed in the previous section. Much of the policy analysis has proposed that the date on which a country establishes a DNA is important for the development of a local carbon offset industry. I use this date proxy the extent to which important local institutional actors have been committed to the industry. I develop a dummy variable, $Early\_DNA_i$, which classifies a country by the date on which the country established a DNA. The variable equals one if the country's DNA establishment date was in the first half of DNA's, and zero otherwise. I gratefully acknowledge Paula Castro and Axel Michaelowa at the University of Zurich for sharing their data on the dates on which DNA's were established. I also add the variable, $Effective\_DNA_i$, which attempts to proxy the *capabilities or capacity* of the DNA by measuring the degree to which the DNA's regulatory function may help projects traverse

the UNFCCC approval process. The assumption is that more effective DNA's tend to gain UNFCCC approval more quickly. Thus, $Effective\_DNA_i$, is a dummy variable that equals one if the country's average time (across all periods) between granting of LOA and UNFCCC registration is below the median for all CDM countries.

Dependent Variable

I measure performance in terms of the number of projects developed in $country_i$ and $year_t$. Project count represents growth of the industry. During my sample period, projects have been developed in 95 countries. In many of these countries, the number of projects in a particular year is zero. Thus, the number of projects in a $country_i$ in $year_t$ is highly skewed. To better fit the data to distributional assumptions of my estimation procedure, I log the number of projects, making $Log\_Projects_{it}$ my main dependent variable. In a robustness analysis, I also run a model with $Projects_{it}$, without logging. In the table below, I show the number of projects proposed during the study period in the major countries. In Table 6, I report project counts for the most significant countries. I aggregate the projects in the remaining countries to the region level for brevity.

Table 7: Projects Proposed by region

region2	2003	2004	2005	2006	2007	2008	2009	2010	2011	Total
Africa	0	2	13	20	18	37	40	40	20	190
Africa	0	2	13	20	18	37	40	40	73	243
Other Asia/Pacific	1	5	65	74	211	227	179	150	293	1205
Europe/Central Asia	0	1	5	8	16	14	15	16	23	98
Latin America	2	17	69	49	74	91	56	74	116	548
Middle-East	0	0	1	8	17	26	6	23	18	99
Brazil	1	18	91	82	70	101	74	42	79	558
China	0	2	25	226	694	655	500	579	999	3680
India	1	10	207	298	308	373	325	384	442	2348
Mexico	0	4	23	119	37	24	19	19	22	267
Total	5	59	499	884	1445	1548	1214	1327	2065	9046

Control Variables

I employ several control variables to proxy for variance in the likelihood for projects across countries and years. Prior research in energy policy has indicated that GHG mitigation potential, investment climate, and capacity of government staff influence the potential for projects. To proxy the degree to which larger economies and populations tend to create more potential for projects, I add yearly measures of GDP (GDP_{it}) and population ($population_{it}$), which are gathered by the United Nations and reported in the World Development Indicators. I also proxy the potential for GHG mitigation with (lagged) yearly measures of country-level GHG emissions ($CO2e_{it}$)from the Carbon Dioxide Information Analysis Center (CDIAC, 2011). To proxy general strength of economic institutions, I use the Regulatory Quality ($Regulatory\ Quality_{it}$). This is one of six dimensions of governance gathered from the World Wide Governance Indicators (Kaufmann et al., 2010) through international surveys of perceptions of households,

firms, public-sector bodies, and non-governmental organizations. This measure seeks to capture "perceptions of the ability of the government to formulate and implement sound policies and regulations that permit and promote private sector development." (Kaufmann et al., 2010: 4).

As discussed in Chapter 3, projects can be developed in a variety of industrial sectors. As in Chapter 3, I proxy the propensity in a given year for carbon offsets to be produced in a particular industrial sector with $sector\_projects_{it}$, which is the weighted average of the sectors in which the country operates. Some countries may also have more potential for industry growth due to a larger number of sectors from which carbon offsets can be produced, so I also include the number of sectors in which a country operated in the prior two years (projects are sometimes not submitted in every year). I label this variable as $sector\_scope_{it}$. The descriptive statistics and correlations among these variables are displayed in Table 7, below.

Table 8: Institution-Building Spillover Descriptive Statistics and Correlations

	Variable	Mean	S.D.	Min	Max	1	2	3	4	5	6	7	8	9
1	Host_ctry's log_projects	-0.64	2.08	-2.3	6.54									
2	Sector_projects	0.32	0.67	0	5.05	0.48								
3	Sector_scope(lagged)	0.36	0.92	0	6	0.15	0.15							
4	GDP (Current ($B US)	126.35	380.4	0.69	4522	0.52	0.12	0.03						
5	Population (millions)	53.90	181.4	0.31	1325	0.45	0.06	0.03	0.80					
6	CO2e, (Billions of tons)	0.15	0.67	0	7.03	0.38	0.07	-0.02	0.90	0.86				
7	Regulatory quality	-0.28	0.73	-2.4	1.97	0.28	0.13	0.03	0.13	-0.01	0.03			
8	Authoring (lagged)	0.61	1.81	0	17	0.59	0.17	0.23	0.69	0.58	0.49	0.17		
9	Early DNA*Authoring (lagged)	0.06	0.39	0	5	0.10	0.00	0.11	0.04	0.06	0.01	-0.02	0.17	
10	Effective DNA*Authoring (lagged)	0.18	1.07	0	14	0.27	0.05	0.00	0.27	0.06	0.04	0.09	0.55	-0.02

4.45 Empirical Strategy

I estimate the relationship between institution building originating in a particular country and subsequent growth of the industry in that country. Methodology authorship is a choice which may be influenced by the same characteristics that also determine growth in the industry. I have included some proxies for these characteristics. However, these unobservable country characteristics, which I cannot satisfactorily proxy, could be omitted variables that bias coefficient estimates, since they can influence both the propensity for institution building as well as industry growth. Moreover, there is likely to be correlation across time since prior project levels are likely to influence future levels. For these reasons, I use dynamic panel estimation and the Arellano-Bond estimator to overcome the problems of serial correlation and endogeneity. Dynamic panel estimation uses lags of prior year performance and other independent variables to develop an instrument with minimal assumptions for the prior year's performance. I use the two-step procedure and use lags of three years and deeper for creating the set of instruments.

4.5. RESULTS

Results of the spillover hypotheses are shown in the table below. The interpretation of these results follows the table.

Table 9: Institution Building Spillover Results

Dynamic Panel Models of Logged Project Number					
	Model 1	**Model 2**	**Model 3**	**Model 4**	**Model 5**
	b/se	**b/se**	**b/se**	**b/se**	**b/se**
Log projects (lagged)	0.818***	0.769***	0.765***	0.745***	0.769***
	-0.045	-0.033	-0.031	-0.023	-0.023
year== 2004	0.591***	0.374**	0.410***	0.388***	0.456***
	-0.153	-0.12	-0.118	-0.108	-0.113
year== 2005	1.021***	0.865***	0.912***	0.889***	1.021***
	-0.166	-0.148	-0.145	-0.115	-0.117
year== 2006	0.392***	0.273***	0.291***	0.282***	0.304***
	-0.086	-0.056	-0.053	-0.055	-0.036
year== 2007	0.492***	0.345***	0.349***	0.226*	0.266**
	-0.091	-0.075	-0.072	-0.09	-0.098
year== 2008	0.455***	0.281***	0.280***	0.238**	0.199**
	-0.075	-0.068	-0.062	-0.081	-0.062
Sector_projects	0.711***	0.893***	0.960***	1.098***	1.136***
	-0.085	-0.061	-0.057	-0.045	-0.05
Sector_scope	-0.036	-0.023	-0.017	-0.016	-0.02
	-0.032	-0.03	-0.031	-0.036	-0.032
GDP (Current , $B)	0	0.001***	0.001***	0.001***	0.001***
	0	0	0	0	0
Population (Millions)	0.002***	0.003***	0.003***	0.003***	0.003***
	0	0	0	0	0
CO2e (Billion tons) (lagged)	-0.405+	-0.844***	-0.780***	-0.784***	-0.649***
	-0.208	-0.118	-0.105	-0.083	-0.104
Regulatory quality	0.163*	0.135**	0.129**	0.115*	0.142*
	-0.068	-0.047	-0.047	-0.055	-0.057
Authoring (lagged)		-0.072***	-0.069***	-0.096***	-0.091***
		-0.015	-0.013	-0.017	-0.013
Early DNA*Authoring(lagged)			0.121+		0.137+
			-0.066		-0.074
Effective DNA*Authoring (lagged)				0.061***	0.071***
				-0.012	-0.01
Constant	-0.603***	-0.641***	-0.707***	-0.727***	-0.749***
	-0.074	-0.047	-0.042	-0.045	-0.038
N	575	575	575	551	551
Standard errors in parentheses					
+ significant at 10%;* significant at 5%; ** significant at 1%; *** significant at 0.1%					

Model 1shows a baseline model with only control variables. Model 2 adds lagged methodology authorship (*authoring*). In model 3, I add an interaction (*Early_DNA*authoring(lagged)*) indicating if a methodology authored (in the prior year) is located in a country that set up their DNA early. In model 4, I add an interaction (*Effective_DNA*Authoring(lagged)*) indicating if a the DNA where the methodology was authored (in the prior) tends to have projects that get UNFCCC approval more quickly. In Model 5, all interactions are added.

This analysis indicates that project levels (logged) in the prior year, sector effects, and year effects significantly influence growth in the industry. Moreover, as assumed, population and GDP are positively correlated with project levels. However, the level of GHG emissions is negatively correlated with project counts. This may indicate a greater interest in GHG mitigation in countries that are already cleaner. Regulatory quality is also positively correlated with project counts, as would be assumed based on institutional economics arguments.

Across the models, we find that the main effect of methodology authoring on subsequent performance is significant, but negative, in all of the models. Thus, I find support for Hypothesis 1b rather than the competing Hypothesis 1a. Authoring a methodology is associated with a 7.5% decrease in the number of projects in the subsequent year.

However, I do find support for my second and third hypotheses. Authoring happening in a country where a DNA was established early is associated with 13% more projects in the subsequent year than authoring happening in countries where a DNA was

established later. Thus, Hypothesis 2 is supported. Locations where institutional actors have been supportive and committed tend to help to create spillovers from institution building. Finally, methodology authoring in countries with more effective DNA's (their projects gain UNFCCC approval more quickly) tends to increase the amount of subsequent projects by 6% compared to countries with less effective DNA's. Thus, I find support for Hypothesis 3, that proximate institutional actors that are more capable increase the spillover benefits of institution building.

4.6. DISCUSSION

These results indicate interesting implications with regard to the process of institution-building in emerging industries. Hypothesis 1a was not supported, but rather the competing Hypothesis 1b was supported. This indicates that perhaps the signal of competition is considerably stronger than the signal of support from other institutional actors, at least in this context. Indeed, institution-building activities provide multiple types of information that are important for firms considering entering amid the uncertainty of an emerging industry. In this CDM context, the potential competition in a particular area is more clearly indicated than the support from local government for carbon offset projects.

Due to the idiosyncrasies of this empirical context, further replication is needed in other empirical contexts. Part of these results may be due to the idiosyncratic nature of the way in which individual actors can build the institutions of the carbon offset industry. While this idiosyncrasy allows better identification of the specific actors and actions

involved in building the regulative institutions, it also is also quite unique in that individual actors from the private sector can attempt to shift regulations in various different directions. It appears that some of these directions are counter-productive. As discussed in chapter 2, influence on the rulemaking process might be too open and bottom-up, in that there are a lot of methodologies that have been created that do not seem to help the industry to grow. This empirical limitation may provide an alternative explanation for the negative effect of institution building on subsequent local growth in the industry. Thus, further testing in other contexts is required to adequately conclude that institution-building provides a deterrence signal.

Support for Hypotheses 2 and 3 make contributions to understanding the institution building process in emerging industries. These results indicate that prior institutional work from other institutional actors is important for the growth of an industry in a certain location. Moreover this prior institutional work affects the degree to which the local area can benefit from the work of firms to help build the infrastructure of institutions for the industry. Similarly, not only is the capability of other local institutional actors such as government and non-profit organizations important for the growth of the local industry, but this capability can help increase the local benefit from efforts from the private sector in institution building. Thus, it seems that just as firms should "run in packs' in technological innovation (Van de Ven, 2005), organizations with interests in industry emergence should "run in packs" in building the various institutions needed for the industry. However, these packs extend to other important organizations sometimes not considered to be important for firms.

This study also has several limitations. First, I have argued in terms of the building of institutions more generally. However, I have measured effects of the process of building regulative institutions (by authoring of methodologies) in a very unique empirical setting (the CDM). The information provided by institution-building to potential entrants is likely to vary considerably based on the details of the institution-building activity. Most importantly, support for Hypothesis 1b and not for Hypothesis 1a is likely to depend on the specific institutional details. As mentioned in the results section, in the CDM, authoring of methodologies indicates the presence of a potential competitor more clearly than support of the local national government. However, further research in other contexts would be required to answer whether these arguments hold more generally.

4.7. CONCLUSION

Institution-building signals characteristics about the actors involved in the institution building, it also may signal characteristics of other proximate actors. Moreover, the other institutional actors on whom firms rely in an industry matter. Other capable institutional actors that have demonstrated more enduring favorable commitment to building and industry tend to help increase the spillover benefits of a firm's institution building activities. This indicates that some locations are more capable of building up an infrastructure of institutions to support an emerging industry, which explains how some locations tend to be hotbeds for new industry growth.

5. CONCLUDING REMARKS

Taken together these studies indicate that firms, along with many other institutional actors, can help build the institutions for emerging industries. Chapter 2 shows that there are choices of how firms and regulators can interact in the rulemaking process which influence which firms are involved, as well as how effectively the rules work. Chapter 3 shows that firms can individually benefit from building institutions in an industry, even if those institutions benefit all firms. Chapter 4 shows that other institutional actors affect the degree to which a firm's institution building benefits the industry.

These studies also have broader implications. First, these studies demonstrate that the role of the private sector in creating rules does not have to be only self-interested. In fact, self-interest and collective interest can often overlap (Van de Ven, Sapienza, & Villanueva, 2007). I provide some evidence that there is an argument for involvement in helping to create the institutions (particularly rules) that govern an industry. Entrepreneurs act in many ways to help an emerging industry to survive. The benefit accruing to the entrepreneurs does not need to come from nefarious influence, but can rather come from the visibility that this action provides.

One way of thinking of these institution-building activities is a parallel with the organizational citizenship behavior literature (C. A. Smith, Organ, & Near, 1983). Much of the work at the intersection of institutions and entrepreneurship focuses on the actions of institutional actors other than firms. However, firms play an important role in building institutions. Institution building by firms is a type of "industry citizenship behavior". Firms can go above and beyond their duties to the industry. While related, this is not the

same as corporate social responsibility, in that actions are focused on helping support the industry, rather than meet the demands of various firm stakeholders (Carroll, 1979). Many types of activities can be classified as industry citizenship behaviors, such as organizing conferences and cooperating to provide professional training within an industry.

Institution-building or industry citizenship behaviors, which can occur in both emerging and established industries, represent an important area of research that has received little research attention. This dissertation indicates that these types of actions should receive more research focus for various reasons. First, firms have the best knowledge and capabilities needed for helping to build and maintain the institutions that support their industry. Therefore, they are more likely to be capable of successfully performing industry citizenship behaviors than other types of behaviors that are deemed appropriate for society. And with better capabilities in these areas, industry citizenship behaviors are likely to have more positive social and economic impact than some other activities that are associated with corporate responsibility.

The second contribution that this dissertation makes is the practical understanding of the most recent attempts to deal with climate change. The CDM and carbon markets have been the topic of much scientific investigation in the environmental policy literature in journals like *Climate Policy* and *Energy Policy*. However, it has received little attention in the management literature. This is unfortunate, particularly since, as I mentioned in Chapter 2, the degree of global coordination required to deal with climate change have inspired truly unique and innovative organizational efforts that promise to

teach us new things the private and public sectors can interact. Moreover, it is a context in which data has been gathered that can be used to study organizations and organizational populations (as I have done in Chapters 3 and 4) in developing countries in a very detailed way. Moreover, it is a special case from which much about organizing can be learned.

The data gathered for this dissertation is quite unique. It is unique with respect to studies of the Clean Development Mechanism actions in the methodology creation process and the project development process have not been linked previously. This linking is an important contribution to understanding the CDM. Second, the identification of data on firms operating in the carbon offset industry is also not available in any other governmental or proprietary database. Because the future of the CDM is uncertain after 2012, this dissertation makes an important contribution by gathering this data on organizations that may disappear in the near future.

It is also unique with respect to organizational studies of industry creation. I have gathered data on an emerging industry in real time, which can help us understand not just policy implications, but also the organizational implications related to this important emerging industry dealing with climate change. As mentioned in the introduction, this type of information is often unavailable for emerging industries, which is one reason we have a limited understanding of the industry emergence process. I have also pinpointed institution-building activities at the organizational level, which has previously only been possible in established industries.

Lastly, this dissertation prompts a broader consideration of how institutions function and change. This dissertation was originally motivated by an observation of the process of methodology creation. Observing how methodologies were created caused me to think about institutions and what they would look like if we could see them.

Institutions are often conceptualized as something of a force field, either set to the off position (de-institutionalized) or the on position (institutionalized). For example, Scott writes: "Institutions impose restrictions by defining legal, moral, and cultural boundaries setting off legitimate from illegitimate activities" (Scott, 2001; 50). It is clear here that the focus of interest is on the boundary-creating characteristics of institutions. While one might accept that legitimacy could be conceptualized as a continuous measure, or even a fuzzy-set rather than a crisp-set category (Ragin, 2000), research has focused on which institutions exist or does not exist in a particular institutional field, similar to observing whether an organization exists or does not exist in a particular location. This binary conceptualization is evident in recent theorizing about the presence of institutional voids in emerging markets (Khanna, Palepu, & Sinha, 2005).

Recent propositions among institutional economists indicate perhaps a different image. Yet, recently Nelson (Nelson, 2008; Nelson & Sampat, 2001) and Eggertson (2005, 2008) have proposed that institutions can actually be considered as "social technologies" that describe how "knowledgeable people act and interact where the effective coordination of interaction is key to accomplishment" (Nelson & Sampat, 2001: 40). Nelson has proposed that not all social technologies are institutions, similar to the institutional logics strain of institutional theory (Friedland & Alford, 1991) which

proposes that several competing logics can be theorized before a smaller subset become accepted and institutionalized.

The three papers of this dissertation fit better with a conceptualization of institutions as technologies, and suggest avenues for further understanding how to compare how different institutions coordinate human activity differently. For example, Chapter 2 implies that institutions, similar to technologies, can be more modular or integrated. This may have consequences about the ability to replicate, change, or transfer institutions from one location to another. Chapter 3 indicates a halo effect from being the institution "inventor" even if the institutional invention benefits others. Finally, Chapter 4 indicates that components from prior institutions help current institutions to work better. Thus, many institutional actors, including firms, are involved in helping to build institutions, which act as social technologies, to support an emerging industry.

The institutions that support an industry are built over time. Prior quantitative work at the intersection of institutions and entrepreneurship has focused more on the actions of organizations other than firms and focused more at the effect on the population as a whole. This dissertation documents one provocative example of how firms are involved in helping the shape the taken for granted assumptions, norms of appropriateness, and rules and regulations that support an industry and shows how these institution-building actions can affect policy objectives, growth of the industry, and performance of firms within the industry. Further work in this area is needed to understand the many actions needed to help to develop a new industry.

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