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Institutional Logics and Technology Development: Evidence from the Wind and Solar Energy Industries

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Abstract. The relationship between regionally tied institutional logics and the location of organizations is an important issue in organization theory. Recent work highlights how supportive regional logics can give rise to products or organizations that resonate with these logics and how the geographic patterns that underlie industries may be understood by examining such relationships. This literature has not, however, offered deep attention to the ways in which features of technology—specifically, its inherent uncertainty—may interact with such dynamics. In this paper, we tackle the challenge. Our work examines how the level of support for an environmental-conservation logic within a region is associated with the number of wind and solar equipment manufacturers in that region in the years 1978–2006. By simultaneously exploring the effects of this logic on two similar technologies, our work not only reinforces how logics may interact with organizational activity but also shows how the magnitude and mechanisms of this effect depend on the technology in question. We build on these findings to discuss the importance of examining technologies in detail, including their dimensions of uncertainty, the role of timing in examining the effect of regionally tied logics, and the links between public policy and logics.

Keywords: institutional theory • sustainability/corporate environmentalism • geography of innovation

Introduction

Why do certain types of firms concentrate in certain locations? Traditionally, scholars focused on economic answers to this question, exploring how firm location is shaped by factors such as a region's tax incentives (Buss 2001); technological infrastructure (Feldman and Florida 1994); knowledge spillovers (Jaffe et al. 1993, Audretsch and Feldman 2004); and cluster dynamics tied to the location of a firm's partners, competitors, and customers (Porter 1990). More recently, researchers also have explored the role of social movements and locally tied institutional logics, both in shaping these economic factors and in directly influencing firm founding and locations (Schneiberg 2002, Lee and Sine 2005, Sine and Lee 2009, Russo 2010, Hiatt et al. 2015).

Much of the work at the intersection of institutional logics, geography, and the location of firms focuses on nontechnology settings (e.g., Lounsbury 2007, Weber et al. 2008, Hiatt et al. 2009), whereas other work focuses on technology contexts but investigates only a single technology (e.g., Lee and Sine 2005, Sine and Lee 2009, Pacheco and Dean 2015). Collectively, these studies have contributed much to our understanding of why firms locate where they do, illuminating the influence of local institutional logics and the mechanisms by which these logics act directly and indirectly to shape firm behavior.

At the same time, however, the empirical focus on single technologies or nontechnology settings also has limited the development of theory. Specifically, a core feature of technology development is "uncertainty." Unlike (or at least more so than) products such as soft drinks and grass-fed beef, emerging technologies may not work, may not be manufacturable, may not be reliable, and may come to rely on standards for economies of scale and interoperability that are not yet known or established. Studies that focus explicitly on a technological context, such as wind energy (Sine and Lee 2009, Pacheco and Dean 2015, York et al. 2016), tackle these complexities of technology in part. Yet technologies also vary in types and degrees of uncertainty, and given the emerging nature of technology, uncertainty itself typically wanes over time. Unfortunately, we lack research that compares multiple technologies that vary in uncertainty and that considers how firm location decisions tied to these technologies may interact with local institutional logics. In turn, this lack of attention means that our understanding of these important institutional and regional dynamics remains limited. Our work aims to address this shortcoming.

In this paper, our starting point is the idea that there exists a positive relationship between supportive local institutional logics and the location of firms that are congruent with these logics. We then hypothesize that these relationships will be more pronounced for more uncertain technologies and that they will diminish over time. Moreover, we hypothesize that targeted policies and knowledge spillovers are key mechanisms that underlie these relationships.

We test these hypotheses by examining two juxtaposed community logics across 276 U.S. metropolitan statistical areas (MSAs): a *resource conservation* logic that focuses on preserving natural resources by reducing demand and by filling remaining demand from renewable sources and a *resource exploitation* logic that focuses on serving growing demand from conventional nonrenewable sources. We then match the strength of these logics in each MSA to the prevalence of manufacturers of two technologies that vary in uncertainty: wind energy and solar energy manufacturers. Examining the location of these manufacturers across the 1978–2006 time period, we find mixed support for our hypotheses. Although empirical limitations prevent us from nailing down the causal relationship between local logics and economic development, our results support the suggestion that the relationship between local institutional logics and firm location is contingent on time and on the particularities of technologies themselves, but that features of specific technologies may act in ways we did not predict.

Our work makes three critical contributions. First, we extend work on the relationship between local institutional logics and the nature of local enterprise by underscoring the temporal patterns that underlie this relationship. Second, we illustrate how technologies—including technologies that belong to the same general category, such as "cleantech"—cannot be taken as interchangeable and that scholars and practitioners must instead attend to the particular features of a technology when assessing the influence of regional logics. Finally, we add to conversations on the relationship between logics and public policy and on the different levels at which logics may operate.

Literature Review

Institutional logics are "broad cultural beliefs and rules that structure cognition and fundamentally shape decision making and action in a field" (Marquis and Lounsbury 2007, p. 289). Although early work on institutional logics focused on the societal level (e.g., Friedland and Alford 1991) or on broad groups such as occupations or types of organizations (e.g., Lounsbury 2002, Thornton 2002, Owen-Smith 2003), recent work has emphasized the geographic embeddedness of logics. Specifically, a number of studies focus on how states, regions, and cities can foster unique institutional logics—termed "local," "regional," or "community" logics—that shape organizational action in these localities (Schneiberg 2002, Lounsbury 2007, Marquis et al. 2007, Marquis and Lounsbury 2007, Hiatt et al. 2009). For example, Marquis et al. (2007) describe how Fortune 500 companies headquartered in Cleveland versus Columbus support different kinds of social programs, illustrating how community-level institutional pressures shape corporate social action. Galaskiewicz's studies of philanthropy in Minneapolis–St. Paul emphasize this same mechanism, whereby a shared local frame of reference (Marquis and Battilana 2009) motivates a philanthropic orientation toward the arts (Galaskiewicz and Burt 1991, Galaskiewicz 1997). Lounsbury (2007) documents how Boston-based mutual funds adhered to a "trustee" logic that emphasized wealth preservation, whereas New York-based funds emphasized a "performance" logic that emphasized generating higher returns. In the same vein, Hiatt et al. (2009) show how states' logics with regard to alcohol consumption shaped both the failure of breweries and the establishment of new nonalcoholic beverage producers in these states.

To be clear, this work does not eschew broader field-level logics and phenomena but rather establishes regional or community institutional logics as a unique and powerful influence on organizational behavior. For example, Lee and Lounsbury (2015) examine how community logics in Texas and Louisiana interacted with broader field-level institutional logics to shape toxic-waste emissions in industrial facilities. Thus, they document both a direct effect of a community logic and an indirect effect that moderates the field-level logic. Similarly, Marquis and Lounsbury (2007) examine the interaction between a community logic of governance and a national logic of governance surrounding U.S. banks, and the effect of these competing logics on what happens after acquisition of a local bank. Likewise, Marquis and Battilana (2009) make a case that broader influences do not diminish local ones, but rather amplify them. They write, "With globalization, not only has the local remained important, but in many ways local particularities have become more visible and salient. . . . [B]ecause organizations are simultaneously embedded in geographic communities and organizational fields, by accounting for both of these areas, researchers will better understand isomorphism and change dynamics" (Marquis and Battilana 2009, p. 283).

These and other studies demonstrate how local institutional logics can shape organizational founding, location and activity (Hiatt et al. 2015). They also appeal to different underlying mechanisms. On the one hand, several studies focus directly on political and economic mechanisms. For example, Lee and Sine (2005) show how regional collective action, measured through state-level Sierra Club membership data, shaped state regulatory regimes and thus the activity of independent power producers in these states. Similarly, Schneiberg (2002) examines the rise of mutual fire insurers, tying regional institutional logics to policy changes that facilitated mutuals in these same regions. Although some studies view "politics and power [as] *institutionally* contingent" and others view the "institutional dynamics of diffusion [as] *politically* contingent" (Schneiberg and Lounsbury 2017, p. 297), in both cases the emphasis is on a direct linkage between local institutional logics and political or economic levers.

On the other hand, other studies emphasize cognitive linkages between logics and organizational actions, considering economic and political influences indirectly. For example, Lee et al. (2017) show how local groups of farmers worked to establish a new logic that valued organic production and that distinguished organic and nonorganic food products. Similarly, Sine and Lee (2009) focus on how the construction and propagation of cognitive frameworks, norms, and values—along with regulatory structures—shaped state-level entrepreneurial activity in the wind energy sector. Likewise, Weber et al. (2008) show how a social movement precipitated a shift in logics that supported the rise of grass-fed beef through the mobilization of broad cultural codes and the establishment of a collective identity. In these studies, therefore, social movements and associated logics did not directly target regulatory and economic factors yet nonetheless influenced them.

Finally, other studies highlight knowledge spillovers as a mechanism that links local logics to firm location. Scholars have long cited knowledge spillovers as a force for regional agglomeration (Jaffe et al. 1993, Audretsch and Feldman 1996, 2004). In turn, shared local logics can enhance these spillovers. As Maskell (2001, p. 929) argues, "It is by watching, discussing and comparing dissimilar solutions . . . that firms along the horizontally dimension of the cluster become increasingly engaged in the process of learning and continuous improvement. . . . sharing a communal social culture—including collective beliefs, values, conventions and language—often significantly assists them in this process." The reasoning is that where a particular institutional logic dominates, individuals typically share a depth of knowledge in specific areas related to that logic and they are motivated to share this related knowledge with one another. For example, in a region that values local food production, there will be increased and more effective knowledge sharing *about* local food production. Such regions also share a common vocabulary and "cultural codes" that can aid such sharing (e.g., Weber et al. 2008).

Collectively, these and other studies establish that regionally tied institutional logics are key to understanding why firms concentrate in certain locations. Yet surprisingly, only a handful of studies on the intersection of logics and geography consider technology-based settings.[1] From a theoretical perspective, this lack of attention matters because emerging technologies face extreme uncertainty that may modify the influence of local institutional logics. These dimensions of uncertainty include whether they will "work," whether they will be manufacturable at scale and at a reasonable cost if they do work, whether they will be reliable, and what standards may emerge that may shape interoperability and economies of scale. To be clear, most any new product faces a degree of market uncertainty (e.g., uncertainty about whether consumers will purchase or use it). Yet emerging technologies also factor high on technical uncertainty (Rosenberg 1997), raising questions as to how uncertainty may amplify, moderate, or otherwise influence the effect of locally tied institutional logics and how those effects may change over time.

One possibility, for example, stems from the Sine et al. (2005) investigation of "green" versus "brown" technologies in the independent-power sector. Sine et al. (2005) find that technological risk has a significant effect both on entry into an industry and on the kinds of organizations that enter. By extension, highly uncertain technologies may be more in need of a supportive logic in order to gain a foothold, particularly early on, and those regions that provide such a supportive logic may be more likely to host organizations that produce such technologies. Unfortunately, however, we have little work that explores such theoretical possibilities by directly investigating the intersection of (1) regional institutional logics and (2) the emergence of technologies with varying uncertainty. Indeed, the studies that come closest to addressing this intersection—investigations of regional institutional logics and the location of independent power producers (Lee and Sine 2005) or wind energy firms (Sine and Lee 2009, Pacheco et al. 2014, Pacheco and Dean 2015, York et al. 2016)—each focus on a single technology (almost always wind technology) and do not directly address the issue of technological uncertainty or changes in uncertainty over time.

To summarize, therefore, we know that regional institutional logics shape the location of firms, including technology-based firms. But we do not know how the same regional logics relate to organizations pursuing different technologies with different degrees of uncertainty nor how these relationships may change over time. In fact, as Sine and Lee (2009) acknowledge, "our study demonstrates the importance of social movement organizations to founding activity early in a sector's life cycle. Future work might examine if this relationship weakens over time as the new sector becomes more legitimate and its requisite resources become more taken for granted" (p. 151). Likewise, Pacheco et al. (2014, p. 1629) write, "A limitation of this study is that we do not examine the very earliest days of the wind industry. It could well be that the relationships we observe do not hold at the nascence of emerging industries."

Absent evidence of how differences in technological uncertainty interact with firm location and regional institutional logics over time, we cannot be confident that our theories of these relationships accurately and adequately explain these effects and—given the intense focus of prior work on the wind industry, specifically—that important insights from prior work generalize to other contexts. By extension, our overall understanding of how locally tied logics may shape the locations of technology-based firms remains limited. Our work aims to address this shortcoming.

Environmental Logics and Renewable Power Generation

We leverage competing institutional logics around the natural environment and renewable power generation as a context to develop our hypotheses concerning the intersection of firm location, regional logics, and technological uncertainty. Specifically, we explore two logics: resource exploitation and resource conservation. Under the *resource exploitation* logic, ever-increasing demand for electrical power is met by exploiting available resources. Under this logic, therefore, new power plant construction is based on cost effectiveness, reliability, and the indisputable presumption of continued growth in demand for electricity. Indeed, this logic emerged along with the growth in electrical power generation and consumption in the United States, in which the national average electricity price declined every year but one in the half-century from 1922 through 1971 (Moody's 1976), whereas demand for electricity rose monotonically.

The dominance of the resource exploitation logic eroded after a series of highly disruptive changes that began in the mid-1970s. The Arab oil embargo squeezed fossil fuel supplies, rapidly inflating electricity prices. Worsening the situation were a number of disastrous experiences with nuclear power plants. These resulted from increasing difficulties in siting new nuclear units, as well as financial and managerial misadventures once ground was broken (Cook 1985). Rate setting by regulators had once been a quiet affair, because it dwelt on the extent to which rates should be reduced (Russo 2001). Beginning in the 1970s, however, rate cases became politicized, as interest groups sought to moderate rate increases and challenge the pass-through of cost overruns of both nuclear plants and fossil fuel purchases.

Meanwhile, a different and competing institutional logic began to take shape: *resource conservation*. This logic emphasized the reduction of demand and the meeting of remaining demand from environmentally sustainable sources. As is often the case, the new logic reflected economic, political, and social forces that challenged the previous logic (Schneiberg and Lounsbury 2017). First, the modern environmental movement grew out of salient events such as the 1969 Santa Barbara oil spill and episodes of deadly smog in Japan in the 1960s, along with the publication of well-publicized books such as Rachel Carson's *Silent Spring* in 1962 and Paul Erlich's *The Population Bomb* in 1968. Activity around these and other events culminated in the first global Earth Day, held in 1970. Second, health and pollution concerns about the operation of nuclear power plants and the disposition of spent fuel from reactors gave rise to the antinuclear movement in the United States and Europe. This movement increased pressure on nuclear power, specifically, as a way to meet ever-increasing demand. Third, the idea that energy conservation should be given greater priority gained traction. In an influential 1976 article in *Foreign Affairs*, energy guru Amory Lovins identified two approaches to meeting future energy requirements, which he termed the "soft" path and the "hard" path:

> The first path resembles present federal policy and is essentially an extrapolation of the recent past. The second path combines a prompt and serious commitment to efficient use of energy, rapid development of renewable energy sources matched in scale and in energy quality to end-use needs and special transitional fossil-fuel technologies. (Lovins 1976, p. 65)

Implicit in Lovins' plea for energy efficiency was the idea that conservation must become a part of the solution for meeting energy needs. Indeed, the conservation side of the resource conservation logic is a fundamental differentiator of the two logics. Its guiding principle is simple: it can be better both economically and environmentally to reduce and spread out demand than to build power plants to meet it.

From a critical perspective, the resource conservation logic did not take hold equally in every community. Several factors account for these asymmetries in the emergence of the resource conservation logic. First, preexisting collective values held by a community's citizenry can prompt acceptance of institutional change consistent with those values (Scott 2013). In other words, communities do not have homogeneous values.

New institutional logics that are more consistent with existing values in a community are more likely to take root in that community. For example, in contemporary communities adhering to a resource conservation logic, recycling, the installation of solar equipment on homes, the consumption of organic foods, and the purchase of carbon offsets all enjoy high degrees of normative legitimacy. In turn, new practices consistent with the values that underlie existing practices, such as eating a locavore diet (consisting of food from within a 100-mile radius), are more likely to take root in such communities.

Second, institutional entrepreneurs who push a resource conservation logic typically do so within a particular geographic area. For example, Jerry Brown, in his first tenure as governor of California (1975–1983), positioned resource conservation as a primary policy goal. He staffed the California Public Utilities Commission with progressive and aggressive leaders and even created a new California Energy Commission with wide powers to push this agenda (Galbraith 2010). In Germany, the first Green Party took form in the 1970s and, under the leadership of Petra Kelly, gained prominence as a model that was adopted by activists in other countries (Bahro 1986). The geographic boundaries of political processes, in turn, suggest geographic boundaries around the emergence and/or growth of a logic.

Finally, as these political examples signal, policy makers are more likely to adopt explicit rules that support activities consistent with their constituents' social values (North 1990). For example, policies that support renewable energy are more likely in places where constituents value environmental protection (Sine and Lee 2009). For all of these reasons, we can expect regional variation in the presence and strength of a logic such as resource conservation.

Renewable Power Generation

A resource conservation logic emphasizes not only reduced demand but also the use of renewable resources, such as wind and sunlight, to produce electricity. By contrast, under a resource exploitation logic these sources remained illegitimate, for several reasons. First, wind and solar generating plants are not dispatchable—that is, they cannot deliver power if the day is calm or the sun has set. Given the primacy that the resource exploitation logic places on power generation, such limitations on generation are incompatible with the logic. Moreover, many technologies were unproven, and even proven ones had underappreciated problems. For example, wind turbines can be unsightly and kill birds flying through their blades. Thus, the language of detractors who adhered to a resource exploitation logic reflected a view that renewables are a frivolous substitute for the real thing. For example, the Institute for Energy Research, an energy industry-sponsored think tank, criticized California Governor Arnold Schwarzenegger's embrace of what it called "girlie man energy"; it opined that "politically correct renewables are dilute and resource intensive compared to the muscular energies found in the ground" (Bradley 2011).

At the same time, different methods of renewable energy production, such as wind energy and solar energy, are not simple substitutes for one another, despite their shared membership in the renewable energy category. For example, wind employs a centuries-old mechanical technology whose basic fundamentals have long been understood. Solar, by contrast, employs chemistry and/or heat-transfer principles (described below) with far shallower knowledge bases.

Wind energy also settled on a dominant design (Abernathy and Utterback 1978) much earlier than solar: almost all wind turbines use a horizontal-axis, three-blade upwind design (Gipe 1995, Dodge 2001); by contrast, solar energy research yielded many competing designs for converting sunlight to electricity. The first distinction among these is between photovoltaics (PVs) and high-temperature thermal systems. PVs use cells that convert sunlight directly into electricity; high-temperature thermal systems focus sunshine onto various media whose heat content then creates steam that powers electricity-producing turbines. One thermal system design uses mirrors to focus solar rays on an elevated tower. A second, quite different approach uses parabolic troughs to focus light on small tubes, through which a substance for heat transfer flows. Thus, for large-scale installations of solar electric generation, there remain several competing technologies and no dominant design (Terlaak and Gong 2009).

Finally, wind and solar have experienced vastly different adoption and installation rates. Installation of generation facilities for wind has broadened since the 1970s, whereas solar electricity generation has been placed only in niche markets and remote applications (McVeigh et al. 2000). Information on wind and solar capacity was available starting in 1980 and 2002, respectively. In 2002, only 17 megawatts of solar generation were installed, compared with 2,578 megawatts for wind capacity. By 2012, the totals were 7,000 megawatts and 60,009 megawatts, respectively, demonstrating that the installed capacity of wind remained an order of magnitude larger than that of solar (American Wind Energy Association 2012, Interstate Renewable Energy Council 2012). Collectively, these differences between solar and wind support a conclusion that solar was riskier than wind—a feature that proves important to our hypotheses.

Hypotheses

Our focus is on the relationship between regional institutional logics, emerging uncertain technologies, and firm location. As noted, a number of studies establish a link between regional logics (and/or associated social movements) and organizational action (Schneiberg 2002; Lee and Sine 2005; Lounsbury 2007; Weber et al. 2008; Hiatt et al. 2009, 2015; Sine and Lee 2009; Pacheco and Dean 2015). Thus, each of these studies finds a positive relationship between a community logic, such as environmental preservation or responsible food production, and organizational actions that are compatible with or supported by this logic, such as establishing wind turbine power facilities or farming organic foods. Our baseline expectation in our context, therefore, is that a greater degree of community consensus around a resource conservation logic would be associated with a greater number of wind and solar manufacturers in that community.

As we have argued, however, technologies—even "clean energy" technologies—vary in uncertainty. (Recall that solar was disadvantaged in that it had neither a dominant design nor widespread cost effectiveness.) We believe the impacts of an institutional logic on technology development are moderated by this uncertainty. Both DiMaggio and Powell (1983) and March and Olsen (1976) describe how uncertainty, in general, can lead organizations to turn to their institutional environment for sensemaking and as a guide to appropriate actions. Of course, as we have argued, this institutional environment is geographically embedded. Thus, the institutional environment to which an organization turns in the face of uncertainty is, to some degree, dependent on their location. For example, Marquis et al. (2007) showed that when a business practice—in their case, corporate social action—has higher levels of uncertainty, firms are more likely to look to norms within their local geographic communities for legitimacy (see also Galaskiewicz and Burt 1991 and Galaskiewicz 1997).

We extend these findings to the case of uncertain technologies, building most directly on Sine et al. (2005). In their study of organizational diversity in small power-producer foundings in California and New York, Sine et al. (2005) found that the development of supportive institutions provided incentives for all producers but had a stronger impact on those producers using risky technologies. Whereas Sine et al. (2005) focused on proven "brown" technologies and unproven "green" technologies, we extend their logic to consider two different green technologies: wind and solar energy. As noted, our baseline expectation is that community consensus around a resource conservation logic will be associated with a greater number of both wind *and* solar manufacturers. Yet because solar is riskier than wind and because riskier technologies benefit more from supportive institutions than do less risky technologies, we expect the salutary effect of legitimacy is greater for solar.

This line of argument is consistent with this hypothesis:

Hypothesis 1. *The positive relationship between a community consensus around a resource conservation logic and the number of wind and solar energy equipment manufacturers is moderated by technological uncertainty, such that the effect of the degree of consensus is stronger for solar energy equipment manufacturers than it is for wind energy equipment manufacturers.*

Our next two hypotheses introduce a temporal element to these relationships. We believe that the influence of a local institutional logic will wane over time. Over time, companies stabilize their economic fundamentals and begin to create dependable resource flows. Indeed, in some contemporary applications, the price of renewable energy is comparable with that of electricity produced from nonrenewable sources. In turn, as economic fundamentals improve, the need for social support of the type we have described here recedes. This should moderate the effect of social support, because organizations may be able to establish themselves in communities with lower levels of social support as the economic fundamentals now are more proven.

Over time, we would also expect that new organizational forms would be created and then move toward the mainstream. Experimentation should lead to a refined set of possibilities for successful business models. Such templates, being more codified and having demonstrated success, also should diffuse more easily. In our research context, it was also true that the institutional framework to facilitate power purchases by utilities from solar and wind energy producers matured (Russo 2001), removing an element of risk for the downstream purchasers of equipment. The economic content of these changes partially and increasingly offsets the primary importance of legitimacy to organizational sustenance.

In these ways, over time the legitimacy afforded to organizations under a resource conservation logic becomes less a sine qua non and more one of a number of factors that create opportunities for prospective organizations. Thus, we have the following.

Hypothesis 2. *The positive relationship between a community consensus around a resource conservation logic and the number of wind and solar energy equipment manufacturers will decline across time.*

A natural question thus arises as to whether this relationship will vary across technologies that display different levels of uncertainty. We believe that this decline will be more pronounced the more uncertain the technology. In the discussion that follows, we must qualify our remarks by limiting them to technologies that are technically feasible. The demonstration of technical feasibility represents a breakpoint, when a technology emerges from the invention stage (Roberts 2007). Prior to this point, the technology cannot be presumed to eventually be proven even in a demonstration stage, so that time will not necessary yield advantages.

Across time, as pilot projects are installed and learning takes place, there is a greater release of information the greater the uncertainty of the technology. There is a cascade of issues that are addressed. For example, by the midpoint of our study period, wind energy technology had progressed to the point where technological challenges focused on later-stage issues, such as design of blades, rotors, variable versus fixed speed motors, and drive train optimization (McGowan and Connors 2000). In the case of solar energy, basic technological issues remained. A wide-ranging review of renewable technologies (Johansson et al. 1993) found that with respect to solar technologies, the challenges were more fundamental. It found solar thermal technologies to be new and "a potentially risky investment" (De Laquil et al. 1993, p. 289) and found that photovoltaics faced "a maze of possible routes for reducing costs and improving system performance" (Kelly 1993, p. 325). This perceived difference in technological feasibility is one reason that federal research and development funding still greatly favored solar technology over wind (Schilling and Esmundo 2009).

The upshot is that more technological learning can be expected to emerge across time for the more uncertain technology. A larger stock of objective knowledge about the material prospects of the technology can be expected to reduce the relative influence of more cultural factors. In this way, prospects for technological feasibility are increasingly joined or supplanted by economic concerns. Quoting Rosenberg (1996, p. 336),

> After a new technological capability has been established, the questions change and . . . new uncertainties, particularly uncertainties, especially uncertainties of a specifically economic nature, begin to assert themselves.

Thus, the technology that reduces uncertainty more quickly will also see the influence of a supportive cultural context lessen more quickly. Hence, we have the following.

Hypothesis 3. *The decline over time in the relationship between a resource conservation logic and the number of wind and solar energy equipment manufacturers is moderated by technological uncertainty, such that the decline is steeper for solar energy equipment manufacturers than it is for wind energy equipment manufacturers.*

Our final two hypotheses consider two of the primary mechanisms that link regional institutional logics and the location of firms. As noted, prior work establishes supportive government policies as a key mechanism that translates regional institutional logics into action (e.g., Schneiberg 2002, Lee and Sine 2005). First, logics connect to public policies that, in turn, affect firm location decisions. For instance, citizens of a region characterized by a certain logic, such as environmental conservation, may be more likely to elect leaders and legislators who share a commitment to this logic. In turn, these leaders and legislators are more likely to propose and implement policies that further the values and activities underpinning the logic—for example, by passing policies that favor environmental actions by firms. Lee and Sine (2005) show just this effect on the state level by linking Sierra Club membership data, a proxy for an environmental logic, to state regulatory regimes and to the activity of independent power producers.

It would also be true that pressure for supportive policies would be based on a broader, shared sense of "self and moral values" (Weber et al. 2008, p. 543) that would translate into passionate lobbying. The presence of activists who can be institutional entrepreneurs (Seo and Creed 2002, Misangyi et al. 2008) is essential to such processes. Receptive agents in the public policy domain, such as California's Jerry Brown, raise prospects for success by helping to legitimate path-breaking ideas. The salutary effect of legitimacy in promoting technological development was noted by Sine et al. (2005) in their study of entrepreneurship in the renewable energy industry. Any lobbying is more likely to be effective where the objectives of lobbyists enjoy a degree of legitimacy.

In our empirical context, much of the institutional action is not at the level of a single community but at levels that aggregate communities, such as states. In turn, prior work leads us to expect that states with resource conservation logics would be more likely to enact policies that support renewable power generation. For example, renewable portfolio standards (RPSs) mandate that a minimum proportion of a state's electrical generation come from renewable technologies by specific years in the future.

We extend this logic to consider policies that target specific technologies. (RPSs typically do not specify which technologies must be used.) For example, states can and do target financial incentives such as tax credits, rapid depreciation, and other stimuli specifically toward solar and/or wind. States, of course, target specific technologies for a reason. We argue that one reason is to enhance the technology's viability (over what it would be in the absence of state support). At the federal level, this precise logic guides federal research and development policy, and it is the reason that these policies have favored solar over wind. Thus, we extend this logic to the state level.

Hypothesis 4. *The greater the strength of community consensus around a resource conservation logic across a state's communities, the more likely it will be for the state to create financial incentives that favor solar energy more than wind energy technology.*

Finally, and as noted, some studies suggest a positive interaction between knowledge spillovers and local institutional logics (Maskell 2001, Weber et al. 2008). We extend these arguments to consider technological uncertainty, arguing that the technological uncertainty associated with solar versus wind power will shape knowledge spillovers. Technological uncertainty creates risk for workers, to the extent that their knowledge is technology specific and path dependent (Teece et al. 1997, Acemoglu 2002). Recall that there was no dominant design for solar energy for most of its history, so that the risk of developing a technology that could ultimately prove fruitless—for example, a particular approach to solar—was tangible. In turn, such failures could prove detrimental to workers' careers. The support of a local belief system helps to mitigate this risk, however, by legitimizing failures suffered in the service of goals consistent with that belief system (Aldrich and Fiol 1994). Thus, supportive local logics may induce more sharing around more uncertain technologies.

For related reasons, when a technology has high(er) uncertainty, it is especially important for technically trained individuals to have exposure to alternatives that might supplant the technology on which they focus. Recall Maskell's (2001) observation that "it is by watching, discussing and comparing dissimilar solutions—often emerging from everyday practices—that firms . . . [in a local] . . . cluster become increasingly engaged in the process of learning and continuous improvement" (p. 929). This process has the ancillary advantage of enabling those who work on an unsuccessful technology to more readily transition to alternative and more successful technologies. Thus, because solar is more uncertain, we expect social dynamics to encourage greater knowledge sharing *between* technologies in those regions with a resource conservation logic.

Finally, coming at the issue from another direction, technological uncertainty has an impact on how knowledge spillovers interact with the strength of a community's resource conservation logic to elicit more firms. Pacheco et al. (2014) studied the effect of industry evolution on social movements, showing that technologically oriented social movement organizations are more numerous the greater the availability of technological knowledge in a state and that the greater the number of these organizations, the greater the wind energy development in a state. This work thus connects knowledge sharing and supportive logics to regional industry activity, suggesting that greater knowledge sharing around an uncertain technology (e.g., solar) would be associated with more related firms (e.g., solar equipment manufacturing firms).

All of these considerations lead to our final hypothesis.

Hypothesis 5. *The interactive relationship between a resource conservation logic and the level of knowledge spillovers related to wind and solar energy on the number of equipment manufacturers in that community will be greater for solar energy equipment manufacturers than it would be for wind energy equipment manufacturers.*

Data and Methods

Setting and Time Frame

To test our theory, we utilize the context of resource exploitation and resource conservation logics in the setting of wind and solar energy manufacturing. The time frame for our study begins with the rise of the modern renewable-energy industry in the United States that followed the passage of the Public Utility Regulatory Policies Act of 1978 (PURPA). This law mandated that utilities purchase power from third parties at a price that tracked their marginal costs of power production. PURPA was intended to address the monopsonistic conditions that prevailed at the time. Using their power as the only purchasers of power in a given areas, utilities routinely burdened sellers with onerous contractual obligations (Pechman 1993). For this reason, prior to PURPA, wind and solar energy projects were limited to Department of Energy–funded experimental facilities. Thus, in the late 1970s, a sea change at the level of national politics permitted an important class of material elements of the conservation logic—wind and solar energy facilities—to be enacted on a large scale for the first time. By setting the stage for market entry of nonutility suppliers of electricity, PURPA was a catalyst for the rise of wind and solar energy production and, hence, manufacturers of generation equipment. Our study period runs through 2006, when data for the dependent variable, the annual number of wind and solar equipment manufacturers, became unavailable.

The annual data, from 1978 to 2006, encompass wind and solar energy manufacturers at the MSA level[2] and policy change at the state level. After losing a year to account for lagged variables, we have 28 years and 276 MSAs, resulting in 7,728 observations in our sample for models predicting manufacturers in an MSA. For models predicting state-level outcomes for the adoption of renewable energy portfolios and change in number of state wind and solar incentives, we have 28 years and 50 states, resulting in 1,400 observations.

Dependent Variables

Number of Wind and Solar Energy Equipment Manufacturers in MSA. This dependent variable for the number of wind energy equipment manufacturers or the number of solar energy equipment manufacturers is derived from the *Thomas Register of American Manufacturers* for the years 1978–2006. To accurately identify relevant components, we consulted several sources. We used industry reports listing the essential inputs for wind and solar energy industries (American Wind Energy Association 2002, United States Photovoltaic Industry Roadmap Steering Committee 2003), and we used Renewable Energy Policy Project reports listing wind and solar photovoltaic component manufacturing requirements (Sterzinger and Svrcek 2004, 2005). We interviewed public service commissioners at the 2008 National Association of Regulatory Utility Commissioners Summer Committee Meetings and professionals in the renewable energy field in the western United States. Interviews helped to determine whether all relevant regulatory issues and component manufacturers were included in the study.

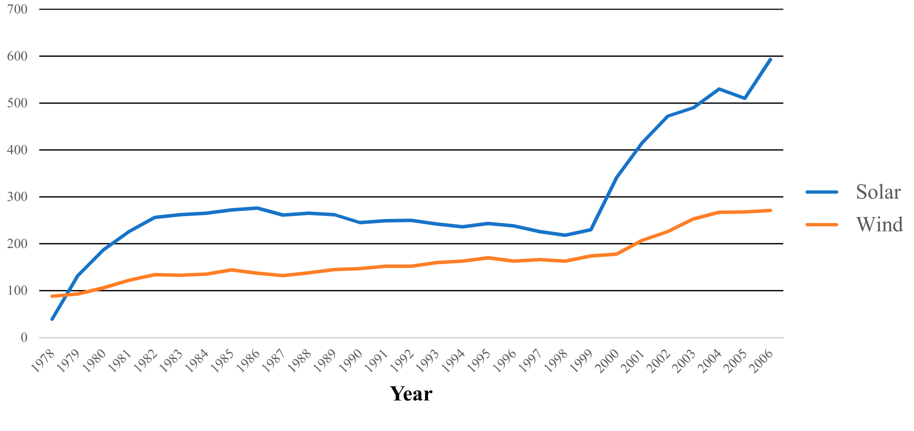
Once we knew essential components of wind and solar energy systems, we then used the *Thomas Register* to create a database of firms manufacturing components and systems. Because different components and systems are needed for the two technologies, for each year, an MSA has a different number of manufacturers for solar and for wind. The *Thomas Register* transitioned from a physical set of compact discs to an online rolling directory in 2007, making retrospective cross-sectional data by year unavailable after 2006. Therefore, our analysis ends in 2006. Figure 1 shows the number of wind and solar equipment manufacturers in the United States over the time frame of the study.

Number of Statewide Wind and Solar Energy Incentives. Hypothesis 4 tests the relationship between a supportive institutional logic and financial incentives for renewable energy at the state level. Separate variables were created for wind and solar, because states adopted different policies toward the two technologies. For the model to test Hypothesis 4, the count of wind incentives or solar incentives is used as the dependent variable. When used in the MSA-level analysis, with the dependent variables of a count of wind manufacturers and a count of solar manufacturers, a count of state incentives applicable to each MSA is used as a control variable. This measure is similar to that used by Lee and Sine (2005) and Sine and Lee (2009). State incentives were identified through listings in the Database of State Incentives for Renewable Energy (DSIRE) 2012). For years prior to the founding of DSIRE in 1995, incentives were identified and confirmed across multiple legal and association publications (Johnson 1979, National Conference of State Legislatures 1982, Solar Rating & Certification Corporation 1985, Interstate Renewable Energy Council 1997).

Explanatory Variables

Strength of Community Consensus Around a Resource Conservation Logic. To measure the extent to which there was a community consensus around a resource conservation logic in an MSA, we utilized the voting patterns of U.S. congressional representatives with respect to the environment. These data are available from the National Environmental Scorecard, published annually by the Conservation Voters (e.g., League of Conservation Voters 1985). This rating reports the votes of members of U.S. Congress on bills that are selected for having proenvironmental and antienvironmental dimensions. An absence counts as an "incorrect" (i.e., antienvironment) vote. The League of Conservation Voters (LCV) reports a score for each representative and senator that runs from 0 to 100, with higher scores indicating a higher percentage of proenvironmental votes. In order to represent the core of an MSA, the House of Representative districts that comprise an MSA are used to create an average LCV score. LCV scores have

Figure 1. (Color online) Numbers of Wind and Solar Energy Equipment Manufacturers in the United States, 1978—2006



been used in previous research to measure the environmental sensitivity of citizens (Terry and Yandle 1997, Delmas et al. 2007, York et al. 2018) and thus would covary with the extent to which the resource conservation logic was embraced and the resource exploitation logic was opposed in that MSA.[3] The average of the annual LCV scores for each state's two U.S. senators was used for the models with dependent variables of the change in wind and solar incentives that occurred at the state level.[4]

Wind Knowledge Spillovers and Solar Knowledge Spillovers. Hypothesis 5 focuses on the relationship between relevant knowledge spillovers and the number of wind and solar manufacturers in an MSA. To test the hypothesis, knowledge spillovers are represented by the underlying science that is developed in related university departments (Stuart and Sorenson 2003, Owen-Smith and Powell 2004). Several researchers have shown that knowledge spillovers fall sharply beyond a 100-mile radius (e.g., Jaffe et al. 1993, Gittelman 2007). Therefore, only universities located in MSAs were considered to be a source of knowledge spillover in the MSA. The explanatory variable for knowledge spillover was proxied by the total annual research spending by all universities in each MSA in the relevant engineering disciplines for wind and solar energy (National Science Foundation, National Center for Science and Engineering Statistics 2013). Relevant engineering disciplines for wind energy are aerospace, electrical, and mechanical; for solar, they are chemical, electrical, and mechanical (Fasulo and Walker 2007).

Technological Uncertainty. In order to test the hypotheses about the impact of greater technological uncertainty on manufacturers, we test for differences in relevant coefficients between models estimating wind and solar equipment manufacturers. Our samples of wind and solar energy equipment manufacturers represent two separate populations; we can take advantage of the fact that the technological uncertainty associated with the two was dramatically different. As noted previously, wind energy technology embodied less technological uncertainty than did solar energy technology, as evidenced by the establishment of a dominant design for wind turbines and the fact that wind energy enjoyed a far greater number of cumulative installations. Therefore, to measure variation on technological uncertainty, we compare outcomes for wind energy equipment manufacturers with outcomes for their solar counterparts.

Control Variables

State and MSA Population. In order to tease out a social influence represented by an institutional logic, we needed to control for a number of economic variables. We obtained information for MSA populations from the IHS Global Insight database (Global Insight 2009). For the 25 MSAs for which IHS Global Insight did not have populations, we compiled Census Bureau data for the population of relevant counties to create a measure (U.S. Census Bureau 1982). The state population is used for the state-level analyses of RPS legislation and change in incentives (U.S. Census Bureau 1982).

Change in Real Gross State Product. To account for a state's economic environment, the analysis includes the percentage of growth in real (i.e., inflation-adjusted) per-capita gross state product (U.S. Bureau of Economic Analysis 2013).

Statewide Change in Real Electricity Prices. To control for a state's sensitivity to electricity prices, the analysis includes the percentage increase in real average electricity prices (Energy Information Administration 2000).

MSA Skilled Wind Labor and Skilled Solar Labor. Specific human skills could contribute to prospects for manufacturing, so we control for the level of skilled labor within MSAs. The variables are created differently for the two technologies (wind and solar), drawing on relevant Standard Industrial Classification (SIC) codes for each manufacturing base (U.S. Photovoltaic Industry Roadmap Steering Committee 2003; Sterzinger and Svrcek 2004, 2005). Labor data came from the Bureau of Labor Statistics' Covered Employment and Wages Program, which provides MSA-level data for the first three digits of SIC codes. To scale these data, skilled labor is in thousands.

Statewide Wind Energy and Solar Energy Potential. We account for natural resource conditions for production of wind and solar energy, because this could influence legislative willingness to support renewable energy production. To create these two variables, we determined the amount, in square kilometers, of the state's area with high wind and solar potential. High wind energy potential is set at Class 4 and above (Energy Information Administration 2000), which is roughly 8 mph on average. High solar energy potential is set at an annual threshold of 5,000 watt-hours per square meter per day and above (National Renewable Energy Laboratories 2009).

Renewable Portfolio Standard. An RPS mandates a minimum level of renewable energy generation and/or purchases by utilities at a state level. Using the Database of State Incentives for Renewable Energy (DSIRE 2012), an indicator variable is coded 1 for years where a state implemented an RPS and 0 otherwise.

Democratic Control of State Legislature. Because dominance by a single party within a state legislature may impact the passage of renewable portfolio standards or alternative energy–promoting incentives, it is important to control for this influence. To pick up the effect of party dominance on state politics, we included a dummy variable coded 1 if the Democratic Party controlled both houses within a state's legislature. The data come from the Council of State Government's *Book of the States* from 1978 to 2006, which was published biennially until 2003, so the years from 1978 to 2002 include interpolated data to fill in the missing years.

In cases where an MSA spanned state lines (e.g., St. Louis), we averaged relevant state values. All explanatory and control variables were lagged one year, with the exception of the RPS indicator and the count of state wind and solar incentives. (These incentives only impact the years for which they are in effect.) The natural logarithms of population, wind and solar research and development spending, energy potential, and labor were used to improve their linear relationship with the dependent variables. Prior to logging, all values had 1 added in order to avoid inadvertently logging a value of 0. To address the issue of high collinearity of interaction terms with direct effects, when we constructed the interaction terms, we centered variables prior to multiplying them (Aiken and West 1991). Because our data set contains 276 MSAs across 28 years, cross-section dependence and nonstationarity are concerns (Baglati 2008). To test for this possibility, we used a Levin-Lin-Chu test (Levin et al. 2002). The null hypothesis assumes common trends among the variables and therefore nonstationarity. We also included fixed effects for years in our models. These fixed effects pick up the contemporaneous effect of other macroeconomic fundamentals that change with time across all MSAs, such as interest rates, as well as the effects of federal policies.

Estimation

Because our dependent variables are counts, we utilized a Poisson estimation for our models. A robustness check using (a) a negative binomial model, (b) a Tobit model, and (c) a two-stage model presented similar results as the Poisson models. Although a panel Poisson or negative binomial model could be an improvement in our case, the models we ran using that specification would not converge in either of the two different software applications we used. As a result, the models are estimated using Poisson regression with lagged variables, year control variables, and standard errors clustered on MSA or state. We used Stata 13 for this purpose.

We utilize a paired difference *t*-test specific to coefficients (Paternoster et al. 1998) to test for the differences between the populations of wind and solar energy manufacturers that represent different levels of technological uncertainty (Hypotheses 1, 4, and 5) and between time periods (Hypothesis 3). For one of these comparisons, one of the coefficients is not significant. This does not invalidate our ability to compare coefficients for a significant difference. Given standard errors for both coefficients, a comparison test and a joint test can still be conducted. In order to test Hypothesis 2, we test whether an interaction term consisting of our resource conservation logic variable and a time trend is significant.[5]

We utilized a Granger test (Granger 1969) to understand possible reverse causality. To determine whether there is a relationship between manufacturers and subsequent LCV ratings, we regressed the lagged count of wind companies and then solar companies on the LCV ratings. For wind, the coefficient is significant but very small ($\beta = 0.006$), resulting in a very small practical influence. For solar, the coefficient is not significant. To determine whether the presence of wind or solar equipment manufacturers is related to state-level policy, we lagged those manufacturers in estimations of change in wind and solar incentives. In neither of the models is the wind or solar equipment manufacturer variable significant. These results do not eliminate the possibility of reverse causality but indicate that the relationship between manufacturers and subsequent legislative choices is weak.

Results

Tables 1 and 2 present the summary statistics and correlations for the estimations of the number of wind and solar energy equipment manufacturers in MSAs. In both cases, a few correlations are high for both wind and solar energy equipment manufacturing. As might be expected, population is correlated with each type of manufacturing, as well as with the level of knowledge spillovers for wind or solar in an MSA, providing some evidence that knowledge spillovers are connected to both wind and solar equipment manufacturing. We checked the variance inflation factors (VIFs) for the variables in the models. *MSA Population* displayed the greatest VIF for both the models with wind manufacturing (VIF = 1.69) and solar manufacturing (VIF = 1.63) as the dependent variables. These values are below a VIF of 10, at which point there would have been concern for too much variance.

Table 3 reports descriptive statistics and correlation tables for the state-level variables used to study the determinants of adoptions of incentives for wind and solar energy, respectively. None of the variables is skewed widely. For both real gross state product (GSP) growth and real state electricity price increases, the large values for minimums and maximums are from Alaska and Hawaii. During the study period, those states experienced significant swings in GSP

Table 1. Correlations—Wind Energy Equipment Manufacturing Companies

		Mean	S.D.	Min	Max	1	2	3	4	5	6	7	8	9
1	*Wind Energy Equipment Mfrs in MSA*	0.60	2.15	0	33									
2	*MSA Population* (thousands)[a]	5.76	1.11	3.95	13.71	0.56								
3	*Change in Real Gross State Product* (%)	2.61	3.51	−28.53	32.51	0.00	0.03							
4	*Statewide Change in Real Electricity Price* (%)	−1.22	4.63	−27.92	24.37	0.03	0.02	−0.06						
5	*MSA Wind Skilled Labor*[a]	0.16	0.14	0	0.65	0.12	0.18	−0.02	0.02					
6	*Wind Knowledge Spillovers*[a]	0.70	1.15	0	5.86	0.52	0.59	0.02	0.02	0.07				
7	*Wind Energy Potential*[a]	7.44	4.45	0	12.35	0.10	0.00	0.02	0.03	0.16	0.09			
8	*Renewable Portfolio Standard in Place*	0.10	0.31	0	1	0.17	0.11	0.03	0.14	0.05	0.12	0.12		
9	*Number of Statewide Wind Incentives*	1.14	1.19	0	6	0.09	0.03	−0.04	0.08	0.23	0.08	0.34	0.20	
10	*Strength of Community Consensus Around a Resource Conservation Logic*[b]	0.40	0.28	0	1	0.24	0.24	−0.04	−0.02	0.06	0.19	0.10	0.07	0.20

Note. Correlations greater than |0.021| are significant at the 5% level.
[a]Logged variable.
[b]Figures were divided by 100 to facilitate presentation of regression results.

and electricity prices, respectively. We see indications that the presence of an RPS and changes in incentives are not strongly correlated, suggesting that they may operate as policy substitutes. This possibility is addressed in the regression analysis. On the other hand, the strong correlation between wind and solar incentives means that states tended to target these technologies through similar tools.

Regression results for MSA-level models with the dependent variables of counts of wind energy equipment manufacturers (denoted with "W" models at head of columns) and counts of solar energy equipment manufacturers (denoted by an "S") appear in Tables 4 and 5, respectively. These models were used to test Hypotheses 1, 2, 3, and 5. Regression analyses used to test Hypothesis 4 are presented in Table 6. We now discuss our results sequentially, in the order of the hypotheses as we presented them.

Hypothesis 1 predicts a stronger direct relationship between a community consensus around an institutional logic for solar equipment manufacturing companies than for wind manufacturing companies.[6] Before addressing this test, we first consider the effect of control variables and the direct effect of knowledge spillovers on wind and solar energy equipment manufacturers in all models. Results appear in models (W1) and (S1). Their pattern of effects and significance is generally similar. Greater population is associated with more wind and solar energy equipment manufacturers, validating a size effect. Coefficients are negative in both cases for gross state product growth and electricity prices. This result, which is consistent across models, may be related to the fact that during our study period, the real price of electricity actually declined. Having greater numbers of skilled workers is not significant for wind energy manufacturers but is positive and significant for solar energy manufacturers. Whereas the extent of wind energy potential and the presence of a renewable portfolio standard are significantly associated with wind energy manufacturers, in the case of solar energy manufacturers, neither is significant. The impact of solar or wind incentives is not significant. Together with previous results, this indicates a lack of connection between some macroeconomic factors, resource potential, and manufacturers.

Table 2. Correlations—Solar Energy Equipment Manufacturing Companies

		Mean	S.D.	Min	Max	1	2	3	4	5	6	7	8	9
1	*Solar Energy Equipment Mfrs in MSA*	1.05	4.16	0	68									
2	*MSA Population* (thousands)[a]	5.76	1.11	3.95	13.71	0.55								
3	*Change in Real Gross State Product* (%)	2.61	3.51	−28.53	32.51	0.01	0.03							
4	*Statewide Change in Real Electricity Price* (%)	−1.22	4.63	−27.92	24.37	0.04	0.02	−0.06						
5	*MSA Solar Skilled Labor*[a]	0.10	0.10	0	0.69	0.16	0.16	0.02	0.03					
6	*Solar Knowledge Spillovers*[a]	0.66	1.12	0	5.26	0.49	0.58	0.02	0.02	0.06				
7	*Solar Energy Potential*[a]	6.52	5.74	0	13.2	−0.04	−0.03	0.19	0.06	0.1	−0.07			
8	*Renewable Portfolio Standard in Place*	0.10	0.31	0	1	0.15	0.11	0.03	0.14	0.06	0.12	−0.09		
9	*Number of Statewide Solar Incentives*	1.57	1.29	0	7	0.08	0.06	0.02	0.08	0.31	0.05	0.21	0.18	
10	*Strength of Community Consensus Around a Resource Conservation Logic*[b]	0.40	0.28	0	1	0.18	0.24	−0.04	−0.02	0.04	0.18	−0.22	0.07	0.13

Note. Correlations greater than |0.021| are significant at the 5% level.
[a]Logged variable.
[b]Figures were divided by 100 to facilitate presentation of regression results.

Table 3. Correlations—Determinants of Changes in Incentives for Wind and Solar Energy Development

		Mean	S.D.	Min	Max	1	2	3	4	5	6	7	8	9
1	*Number of Statewide Wind Incentives*	1.13	1.28	0	6									
2	*Number of Statewide Solar Incentives*	1.40	1.33	0	7	0.89								
3	*State Population* (thousands)[a]	14.97	1.01	12.90	17.40	0.12	0.21							
4	*Change in Real Gross State Product* (%)	2.62	4.00	−28.53	32.51	0.00	0.02	−0.02						
5	*Statewide Change in Real Electricity Price* (%)	−1.25	4.89	−27.92	24.37	0.09	0.10	0.00	−0.10					
6	*Statewide Wind Energy Potential*[a]	7.59	4.48	0	12.35	0.23	0.19	−0.07	0.04	0.01				
7	*Statewide Solar Energy Potential*[a]	5.48	5.68	0	13.20	0.03	0.13	−0.06	0.10	0.03	0.36			
8	*Renewable Portfolio Standard in Place*	0.08	0.28	0	1	0.21	0.02	0.08	0.02	0.14	0.06	−0.13		
9	*Democratic Control of State Legislature*	0.54	0.50	0	1	−0.01	0.07	0.15	−0.03	−0.03	−0.21	−0.04	0.01	
10	*Strength of Community Consensus Around a Resource Conservation Logic*[b]	0.47	0.29	0	1	0.24	0.25	0.10	−0.02	0.00	0.01	−0.44	0.18	0.12

Note. Correlations greater than |0.021| are significant at the 5% level.
[a]Logged variable.
[b]Figures were divided by 100 to facilitate presentation of regression results.

Models (W2) and (S2) provide the basis for testing Hypothesis 1 by adding the resource conservation logic to the equations with control variables. For wind, its coefficient is highly significant, but for solar, it is insignificant. We do see the coefficient for solar become significant in model (S3), when the interaction variable of community consensus and time is included in the model. This indicates that time may be important in the relationship between a supportive logic and the number of solar energy manufacturers.

Table 4. Regression Results—Wind Energy Equipment Manufacturing Companies (Dependent Variable: *Number of Wind Energy Manufacturers in MSA*)

	(W1)	(W2)	(W3)	(W4)
MSA Population (thousands)[a,b]	0.671***	0.634***	0.635***	0.622***
	(0.092)	(0.089)	(0.088)	(0.088)
Change in Real Gross State Product (%)[b]	−0.041***	−0.035**	−0.037**	−0.037**
	(0.015)	(0.015)	(0.016)	(0.017)
Statewide Change in Real Electricity Price (%)[b]	−0.012***	−0.012***	−0.012***	−0.012***
	(0.004)	(0.004)	(0.004)	(0.004)
MSA Wind Skilled Labor[a,b]	0.103	0.178	0.123	0.130
	(0.463)	(0.471)	(0.483)	(0.459)
Wind Knowledge Spillovers[a,b]	0.414***	0.368***	0.368***	0.425***
	(0.070)	(0.069)	(0.068)	(0.079)
Statewide Wind Energy Potential[a]	0.081***	0.081***	0.080***	0.081***
	(0.030)	(0.029)	(0.029)	(0.029)
Renewable Portfolio Standard in Place[b]	0.557***	0.446***	0.500***	0.534***
	(0.171)	(0.178)	(0.173)	(0.166)
Number of Statewide Wind Incentives	0.024	−0.007	0.001	0.005
	(0.064)	(0.060)	(0.060)	(0.058)
Strength of Community Consensus Around a Resource Conservation Logic[b]		1.136***	1.328***	1.450***
		(0.291)	(0.305)	(0.319)
Strength of Community Consensus Around a Resource Conservation Logic[b] × *Time*[c]			−0.057***	−0.046**
			(0.022)	(0.022)
Strength of Community Consensus Around a Resource Conservation Logic[b] × *Wind Knowledge Spillovers*[a,b,c]				−0.009*
				(0.007)
Constant	−6.370***	−6.699***	−6.948***	−6.991***
	(0.603)	(0.571)	(0.573)	(0.559)
Observations	7,728	7,728	7,728	7,728
Log likelihood	−5,005.25	−4,881.69	−4,856.46	−4,838.92

Note. Standard errors are in parentheses, errors are clustered on MSA, and year control variables are not shown.
[a]Logged variable.
[b]Lagged variable.
[c]Constituent terms centered.
***$p < 0.01$; **$p < 0.05$; *$p < 0.10$ (one-tailed test).

Table 5. Regression Results—Solar Energy Equipment Manufacturing Companies (Dependent Variable: *Number of Solar Energy Manufacturers in MSA*)

	(S1)	(S2)	(S3)	(S4)
MSA Population (thousands)[a,b]	0.677***	0.672***	0.675***	0.693***
	(0.095)	(0.095)	(0.094)	(0.094)
Change in Real Gross State Product (%)[b]	−0.022**	−0.022**	−0.024**	−0.022**
	(0.012)	(0.012)	(0.012)	(0.012)
Statewide Change in Real Electricity Price (%)[b]	−0.019***	−0.019***	−0.019***	−0.020***
	(0.004)	(0.004)	(0.004)	(0.004)
MSA Solar Skilled Labor[a,b]	2.391***	2.369***	2.277***	2.215***
	(0.635)	(0.641)	(0.650)	(0.651)
Solar Knowledge Spillovers[a,b]	0.450***	0.443***	0.439***	0.387***
	(0.089)	(0.089)	(0.088)	(0.085)
Statewide Solar Energy Potential[a]	−0.010	−0.008	−0.007	−0.008
	(0.016)	(0.016)	(0.016)	(0.016)
Renewable Portfolio Standard in Place	0.124	0.112	0.167	0.116
	(0.126)	(0.128)	(0.133)	(0.143)
Number of Statewide Solar Incentives	−0.054	−0.058	−0.053	−0.051
	(0.047)	(0.047)	(0.047)	(0.046)
Strength of Community Consensus Around a Resource Conservation Logic[b]		0.169	0.346*	0.150
		(0.237)	(0.248)	(0.266)
Strength of Community Consensus Around a Resource Conservation Logic[b] × *Time*[c]			−0.045***	−0.061***
			(0.017)	(0.021)
Strength of Community Consensus Around a Resource Conservation Logic[b] × *Solar Knowledge Spillovers*[a,b,c]				0.011**
				(0.006)
Constant	−5.801***	−5.841***	−6.041***	−6.024***
	(0.585)	(0.589)	(0.587)	(0.595)
Observations	7,728	7,728	7,728	7,728
Log likelihood	−6,860.12	−6,855.90	−6,826.69	−6,790.06

Note. Standard errors are in parentheses, errors are clustered on MSA, and year control variables are not shown.
[a]Logged variable.
[b]Lagged variable.
[c]Constituent terms centered.
***$p < 0.01$; **$p < 0.05$; *$p < 0.10$ (one-tailed test).

To test Hypothesis 1, we applied a test recommended by Paternoster et al. (1998). The coefficient for the direct effect of the resource conservation logic on wind energy equipment manufacturers in model (W2) is greater than the corresponding coefficient on solar energy equipment manufacturers in model (S2) ($z = -2.58$, $p < 0.01$), which is opposite to our prediction. Thus, we fail to find support for Hypothesis 1, which predicted a stronger effect of a supportive institutional logic for solar manufacturing than for wind manufacturing.

In models (W3) and (S3), we add an interaction term created by multiplying the resource conservation logic variable and time. We use the results to test Hypotheses 2 and 3. Hypothesis 2 asserts that the influence of the community consensus for resource conservation logic will decrease across time. In the cases of both wind and solar, the coefficients are negatively signed and significant.[7] Hypothesis 2 is supported.

Hypothesis 3 predicts that the decline over time of the effect of a community consensus around a resource conservation logic on the number of wind and solar energy manufacturers will be steeper for solar than for wind. We test this hypothesis by comparing the coefficients on the interaction terms created by multiplying the resource conservation logic variable and time. A comparison of those coefficients in models (W3) and (S3) indicates that the coefficient is greater in the negative direction for wind than for solar; the t-test finds the difference is not significant ($z = 0.05$, $p < 0.50$). Thus, we fail to support Hypothesis 3.

Results for the count of state incentives for wind and solar energy appear in Table 6 and are used to test Hypothesis 4. State population is not significantly related to the number of incentives for wind energy but is significantly related to the number of incentives for solar energy. Change in GSP is not significant in either case. However, electricity prices are significant in the models, indicating a response to diversify energy sources when electricity prices increase. Potential for wind and solar energy is positively tied to both forms of energy, suggesting that policy makers took note of the realistic prospects for cost-effective energy production in their states. The presence of an RPS in

Table 6. Regression Results—Determinants of Wind and Solar Energy Incentives for Wind and Solar Energy Development

	DV: *Count of Incentives*			
	Incentives for wind		Incentives for solar	
	(W5)	(W6)	(S5)	(S6)
State Population (thousands)[a,b]	0.143	0.114	0.197**	0.154**
	(0.117)	(0.113)	(0.089)	(0.086)
Change in Real Gross State Product (%)[b]	−0.004	−0.002	0.004	0.000
	(0.013)	(0.014)	(0.011)	(0.011)
Statewide Change in Real Electricity Price (%)[b]	0.011*	0.012**	0.009**	0.008**
	(0.008)	(0.007)	(0.005)	(0.004)
Statewide Wind Energy Potential[a]	0.070**	0.074**		
	(0.037)	(0.036)		
Statewide Solar Energy Potential[a]			0.026*	0.051***
			(0.017)	(0.017)
Renewable Portfolio Standard in Place	0.496***	0.330**	0.619***	0.460***
	(0.192)	(0.174)	(0.158)	(0.164)
Democratic Control of State Legislature	0.031	−0.024	0.063	0.010
	(0.220)	(0.211)	(0.183)	(0.164)
Strength of Community Consensus Around a Resource Conservation Logic[b]		0.907***		1.155***
		(0.339)		(0.272)
Constant	−2.801*	−2.830**	−3.028**	−3.016***
	(1.761)	(1.663)	(1.321)	(1.214)
Observations	1,400	1,400	1,400	1,400
Log likelihood	−1,985.44	−1,935.78	−2,105.19	−2,024.50

Notes. Standard errors are in parentheses, errors are clustered on state, and year control variables are not shown. DV, dependent variable.
[a]Logged variable.
[b]Lagged variable.
[c]Constituent terms centered.
*** $p < 0.01$; ** $p < 0.05$; * $p < 0.10$ (one-tailed test).

a state is positively and significantly related to wind and solar incentives, which may mean an RPS is a complement to wind and solar energy incentives. Party political control played no role.[8] Turning to the test of Hypothesis 4, we consider models (W6) and (S6) specifically and compare the impact of a resource conservation logic (LCV) on change in solar incentives compared with change in wind incentives. Although the coefficient for resource conservation logic is higher for solar incentives than wind incentives, the difference is not statistically significant ($z = 0.57$, $p < 0.30$). We fail to support Hypothesis 4. However, the positive and significant coefficients for the resource conservation logic in both models indicate strong support for the idea that logics can be translated into materiality through policy initiatives that reflect those logics.

Our final test is of Hypothesis 5, which predicted that the interactive effect of knowledge spillovers and the community consensus around a resource conservation logic would be stronger in the case of solar manufacturers. We test this hypothesis by returning to Tables 4 and 5 and adding an interaction term formed by multiplying the resource conservation logic and knowledge spillover variables. We conduct the test by comparing the magnitude of the coefficients on these interaction terms in models (W4) and (S4). We find that not only was the coefficient on the LCV rating for solar (0.011) higher than for wind (−0.009) but also the difference was significant ($z = 2.17$, $p < 0.05$). Hypothesis 5 is supported. Overall, we received support for two of our hypotheses.

Discussion

Our interest lies in understanding how local institutional logics relate to the location of technology-based firms. Consistent with prior work, we found that regions with an institutional logic that favors a particular type of technology are more likely to host firms that produce this technology. Moreover, we found that this effect diminished over time, signaling that supportive logics are more important in the early stages of a technology life cycle, and we found that knowledge spillovers interacted with supportive logics, with a stronger effect for the more uncertain technology (solar).

Our hypotheses surrounding technological differences received mixed support. Most important, we found that effects on wind and solar differed, despite the fact that these are both green technologies whose adoption grew rapidly in the same time period. These findings provide strong evidence that research on the effects of logics must account for technological differences. One of these differences, however, operated in the opposite direction that we predicted, a point that we discuss below.

Ultimately, our work makes three primary contributions. First, we extend work on the relationship between organizations and local institutional logics by emphasizing temporal patterns that can underlie this relationship. Second, we illuminate how features of technology, including its inherent uncertainty, may interact with institutional logics and we show how even technologies that appear similar on the surface may have different features that modify the effect of institutional logics. Finally, we add to conversations on the ways in which logics operate at different levels and on the interaction between logics and public policy. We discuss each of these contributions in detail below.

Local Institutional Logics and Temporal Dynamics

As noted earlier, prior work establishes that supportive logics can give rise to congruent products, services or businesses, such as nonalcoholic beverages, mutual fire insurers, and grass-fed beef (Schneiberg 2002, Weber et al. 2008, Hiatt et al. 2009). Our paper builds on this work by showing a relationship between local logics and wind and solar energy. Of course, it is difficult to establish causality, and undoubtedly, alternative explanations exist. For instance, it is likely that the presence of related industries, as one example, could shape both congressional voting support for wind/solar energy and the entry of wind/solar firms.

We move beyond this particular relationship, however, by bringing temporal considerations to the forefront. Thus, we find that supportive local logics are indeed associated with the location of complementary firms, but we also find that this effect fades over time. This pattern suggests that other drivers, such as economic considerations, may come to supplant or diminish the role of a supportive institutional logic as a technology matures. Thus, market drivers and nonmarket institutional logics need not be at odds. (Indeed, without clear market drivers—such as mandates or monetary incentives that tilt the economic calculus in favor of uncertain technologies—there may well be a point where social support in and of itself simply cannot elicit change in the first place.) At the same time, however, the relationship between market and nonmarket considerations appears to be one that demands attention to time and timing. Thus, our results reinforce Friedland and Alford's (1991) observation that the cultural and material can be simultaneously present, but also introduces a temporal element into this influence. (See also Lounsbury 2007, Kennedy and Fiss 2009, and Sine and Lee 2009.)

In turn, our results suggest that there will be a juncture at which different paths of causation may be simultaneously at work. For instance, for wind energy manufacturers in our study, the presence of an RPS was positively related to more manufacturers, whereas for solar manufacturers, it was not. By contrast, for solar energy manufacturers, the interaction between knowledge spillovers and a community consensus around a resource-conservation logic was positively related to the number of solar energy manufacturers; yet for wind energy manufacturers, the interaction between knowledge spillovers and a community consensus around a resource-conservation logic was negative and significant. These results can be interpreted as suggesting that different communities, based on their support for the resource conservation logic, might be at different places in terms of the need for market drivers for new technologies. This is one reason that the United States government is (and has been) engaged in a serious debate about the continued need for price supports for alternative energy (Friedrich 2015). One alternative would tie the supports to the technological maturity of a recipient in question (Mueller and Ronen 2015), a suggestion that dovetails with our findings.

It is worth noting, too, that these dynamics can run in both directions, from the cultural to the economic and from the economic to the cultural. Thus, whereas previous work has linked logics to forms of service provision (e.g., Schneiberg 2002, Lounsbury 2007) or product adoption (e.g., Weber et al. 2008), suggesting that logics lead to particular economic outcomes, it also is possible that as technologies, products, or services gain a foothold and grow in a region, they could further the *cultural* rationale and support for these technologies.

For this reason, time also provides a challenge for our study in that it raises questions of sequencing and reverse causality, beginning with the question of where a logic comes from in the first place. Clearly, logics can predate the technologies, products, or industries that they support. For example, Kenney (2000) ties Silicon Valley's risk-taking high-tech entrepreneurs to the history of the western United States, which was populated by risk-taking gold miners. Porter (1998) notes a long history of health and well-being concerns in the Minneapolis–St. Paul region, tied to the Scandinavian immigrants who settled the region, which predated and supported the rise of medical-technology companies in the area. (See also Elazar (1972, p. 96), who ties the Puritan culture of the settlers of Vermont and Wisconsin to the emergence of "moralistic" cultures in which government represented "an effort to exercise power for the betterment of the commonwealth.") Closer to our empirical setting, early steps by a regional or state government to regulate industrial water pollution, out of concern for the environment, can predate the construction of solar manufacturing plants that resonate with a similar concern for the environment.

Nonetheless, noting that logics can predate the technologies and industries that they influence does not fully quell the concern around identifying the *origins* of these logics and the ways in which logics may not be fully exogenous influences on technology development and industry emergence. (They surely are not!) Although our study cannot address these concerns in full, it does suggest potential approaches. For example, future work might fruitfully trace a particular region's history, establishing a detailed chronology of the presence and influence of different logics, supportive economic and policy conditions, and activities of related industries and organizations—and of the changing relationships between all of them. Such research would more directly address questions of origin and sequencing that lie beyond our study.

Technological Contexts and Differences

Our work also contributes to the literature on the effect of local institutional logics by focusing on technology. Organizational scholars have long recognized that technology plays a unique and powerful role in shaping organizations (e.g., Woodward 1958, Perrow 1967, Barley 1986) and that technological products differ from nontechnological products in key respects (e.g., Nelson and Winter 1977, Rosenberg 1997). Although existing work on the effects of local institutional logics examines nontechnology products or single technologies, our study offers an important contribution by testing these relationships for two closely related technologies, thus enabling us to appreciate how the same institutional logics can have different effects even on similar technologies. In turn, these findings point to the need to investigate the particular features of a technology rather than relying on general categories such as "green" or "renewable energy."

We focus particular attention on the uncertainty dimension of technology, and we hypothesized that solar would receive a bigger boost from a supportive institutional logic than would wind because, we reasoned, it had greater uncertainty. We also hypothesized that this effect would decline more rapidly for solar than for wind and that knowledge spillovers would play a more prominent role in the case of solar. Our findings, however, only partially support these hypotheses. We did find that the influence of knowledge spillovers when interacted with a supportive institutional logic was greater on solar energy equipment manufacturers than for wind energy equipment manufacturers, as hypothesized (Hypothesis 5). Yet we also found that a supportive logic was more important for wind, not solar (Hypothesis 1).

One possible explanation for these results is that the elements of uncertainty that were most salient for wind versus solar technologies may *not* have been the existence of a dominant design and the size of the installed base, as we suggested, but rather other features that made *wind*, not solar, more uncertain and thus more likely to benefit from a supportive local logic. Indeed, reassessing the situation, solar had several advantages over wind in the period that we consider. First, solar installations have a major residential market that wind, because of the size and noise of wind turbines, does not. Second, and related, solar technologies can be scaled down for residential applications, whereas residential wind installations primary use a vertical (as opposed to horizontal) axis, thus negating the advantages of a dominant design around horizontal-axis commercial systems. Third, the solar industry is closely tied to the semiconductor industry; thin-film solar cells, computer processors, and computer memory use many of the same materials and manufacturing technologies. This relationship may have made solar investments "safer" because failed attempts could potentially find application in the related semiconductor industry. Finally, precisely because there were more wind turbine installations at the start of our time period (1978), one could argue that, all else being equal, solar would experience more growth and thus make for a more compelling business case.

These possibilities reflect the challenge of examining technology uncertainty because there can be multiple dimensions of technology uncertainty (Milliken 1987, Song and Montoya-Weiss 2001, Adner and Kapoor 2010, Toh and Kim 2013). For example, Rosenberg (1997, p. 159) notes that even though "much of the relevant literature emphasizes the huge uncertainty that has attached to the question, 'will it work?'" more important considerations may include a technology's reliability, cost, integration into a broader sociotechnical system, and the timing of potential improvements in the focal technology as well as complementary inventions. Although we provide initial evidence that technological uncertainty interacts with supportive institutional logics, our mixed results suggest the need for much more investigation into specific elements and types of uncertainty and how they change over time. For example, future research could trace the development of a particular technology and its changing uncertainty along multiple dimensions (e.g., Allen 1977) and could then link these different dimensions to aspects of the institutional environment. Such an in-depth and micro look at technology-development processes could help to further unpack the mechanisms at play in a more macro industry-focused study such as ours.

Acknowledging these extensions, our work nonetheless provides critical evidence that features of technology "matter." Indeed, as we demonstrate, empirical results can vary substantially even for seemingly similar technologies. Given the complexity of interactions between institutional logics, specific economic and policy factors, and specific features of a technology—all of which change over time—our study provides strong encouragement for future work to fully account for particularities and nuances around technology rather than relying on generalities and broad categories.

Policy Dimensions and Nested Institutions

Our work also extends existing research on the relationship between organizations and local institutional logics by emphasizing the importance of policy and by linking policy to institutional logics. Specifically, our results trace out a role for public policy as a platform for articulating and advancing change that can act in consort with supportive values and norms. Indeed, one of the roles of policy in a state or community is to create societal outcomes that reflect the collective will of inhabitants. Thus, public policy is one way that the cultural elements of institutional logics can elicit material elements through an inter-institutional connection from a community to the state. As Scott (2013, p. 7) points out, regulatory, normative, and cultural-cognitive aspects or "pillars" of institutions can be mutually reinforcing: "When the pillars are aligned, the strength of their combined forces can be formidable."

At the same time, our results indicate that there can be different relationships between policy and the normative and cultural-cognitive pillars typically associated with logics. For wind, the direct effect of a community consensus around a supportive logic was strong and remained so in all models. For solar, by contrast, the direct effect of logic was influenced by time and knowledge spillovers. Thus, the two technologies benefitted in different ways from a supportive institutional logic.

Thus, our empirical context allows us to appreciate that the same causal levers—in our case, a common institutional logic and a set of policy interventions—can have different effects on different technologies. Given the asymmetry that we observed, we must ask why. It may be that that regional institutional logics act through mechanisms beyond policy, such as cognitive frameworks that make citizens of a region more receptive to a particular technology, more receptive to the companies that produce it, and more interested in working at such companies. Thus, the starting point is the same (local institutional logic), but the mechanism is focused on cognitive receptivity that can shape processes such as labor and employment (and not only policy, per se). This argument thus mirrors the more cognitively focused work of Lee et al. (2017), Sine and Lee (2009), and Weber et al. (2008).

Finally, the strong role of policy in our account highlights one way in which institutions can be nested and operate at different levels (Meyer 2003, Colyvas and Jonsson 2011). Thus, we demonstrate the interaction between regional (MSA) logics and state-level policies. Yet states, of course, can contain many MSAs, and the dominant logics in these MSAs need not align with one another (or with a state's overall priorities and/or policies). As noted earlier, several studies establish that local logics do not supplant broader institutions but rather interact with them (e.g., Marquis and Lounsbury 2007, Marquis and Battilana 2009, Lee and Lounsbury 2015). Our work suggests that future research might explore both additive and contrasting interactions—in other words, those involving an MSA whose dominant logic aligns with state policies and those involving an MSA whose dominant logic does not. Such interactions between levels may, in fact, be a generative mechanism for institutional change. Toward this goal, Thornton et al. (2012, p. 73) offer a table of ideal institutional orders that compares and contrasts institutions at various levels, including the community and state, and across multiple dimensions, including the sources of legitimacy, authority, and identity and the bases of norms, attention, and strategy. Our work underscores the importance of such comparative research and adds new considerations around the effect of such interactions on the development of uncertain technologies—specifically, those that may be both an outcome and provocateur of institutional dynamics.

In any case, all of these observations also point to policy, specifically as a key mechanism that links institutional logics to action: logics can give rise to policies that further support actions congruent with these logics. Of course, the reverse relationship is almost certainly true, too, as Scott (2013) points out: policies can support or even give rise to logics. In fact, social scientist James Q. Wilson (1980, p. 363) argued that one of the central purposes of the political process is to change the desires and aspirations of the citizenry. In either case, policy provides a critical link between what people think *ought* to be and what actions firms are encouraged or forced to take (or not take).

Managerial Implications

Finally, we wish not to lose sight of the managerial implications of the relationship between local institutional logics and technology development. The finding that supportive institutional logics can have a direct effect on the firms in communities may encourage managers to critically evaluate the institutional environment when selecting locations for competitive advantage. For example, consider firms in faith-based industries. Locating in MSAs where the dominant institutional logic supports religious and spiritual values, and where collaboration with faith-based organizations is appreciated (Institute for Educational Leadership 2005), might enable a company to create a competitive advantage. The long-held view in strategic management, that organizational fit to the *competitive* environment is critical to success, thus can be augmented: success also may depend on organizational fit to the local *institutional* environment. This perspective thus encourages a shift from emphasizing a firm's internal and proprietary resources (Barney 1991) to considering the value of external shared resources (Lavie 2006).

Our results also link to work that has introduced a more culturally informed perspective to managerial theories of value creation (Maurer et al. 2011). In this view, if a firm's resources and capabilities reflect the social values of its context, this can create value for its stakeholders. To a degree, any firm is a creature of its unique history and location, and its values, beliefs, and meanings may closely parallel those of its context. However, to the extent that this is not so, a firm can augment its human resources in a way that reflects new social realities. If choosing where to live can determine the quality of one's professional career (Florida 2008), and if individuals seek to live where their personal values match those of their new communities, this process may be easier than it seems.

A Final Word

Ultimately, our work adds to a small but growing portfolio of studies that investigate how locally tied institutional logics exert significant influence on the activities that take place within these localities. Our work specifically demonstrates the linkages between these logics and firm location, unpacking the temporal dynamics and technological dependence of these relationships. Yet the importance of this work goes beyond theory: in a world confronted with climate change and its dramatic effects on both social and economic well-being, understanding the factors that influence industries such as clean-energy may, in fact, be more important than ever.

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Endnotes

[1] In using the term "technology," we are focused specifically on artifacts whose core value derives from the application of engineering or scientific advances. Thus, although almost any product or process can be considered a technology in some sense, we limit our theorizing to those products commonly identified as "high-tech."

[2] The population threshold of an MSA changes from time to time, so we use the listing of MSAs in 1999 (based on the 1990 definition of MSAs), because it is toward the middle of the data range. We identified the MSAs from 1999 across all years of the data. In 1999, 18 large urban areas that consisted of contiguous MSAs (e.g., Cleveland and Akron) were designated by the Census Bureau to be a combined metropolitan statistical area (CMSA). Because such areas overcome what could be artificial boundaries, in cases where CMSAs were created, we used those instead of MSAs. For simplicity of exposition, we refer to all geographic areas as MSAs.

[3] For example, during the 1980s, issues the League of Conservation Voters used to create voting scores included bills on offshore oil drilling, the selling of coal mining rights on federal lands, home energy conservation, utility nuclear bailouts, solar energy funding, solar and energy conservation tax credits, synthetic fossil fuels, and nuclear waste disposition.

[4] Another possible measure of a local resource conservation logic could be Sierra Club membership, which has been shown to be correlated with LCV scores (Delmas et al. 2007). The advantage of using LCV scores is the ability to create composite scores at the MSA level across 28 years. As an indication of the validity of this measure, at the statewide level, it was found by Sine and Lee (2009) to correlate positively and significantly with Sierra Club membership.

[5] In the specifications we use, when including an interaction term that has a time trend as one of its constituents, there is no need to include the direct effect of the time trend. This is because our model includes fixed effects for years.

[6] Our baseline expectation is that community consensus around a resource conservation logic will be associated with a greater number of both wind *and* solar manufacturers. This is supported with a positive and significant coefficient for the resource conservation logic variable in wind models (W2), (W3), and (W4). For solar models, the direct effect is significant when the interaction of the resource conservation logic and time variables is added, in model (S3).

[7] We explored an alternative specification that splits the sample into two segments (1979–1992 and 1993–2006) and runs the specifications shown in models (W2) and (S2). In both cases, a significant decrease in the effect of the resource conservation model occurs between the earlier and later segments. The results are robust to the choice of a breakpoint, and similar results occur when the segments are (a) 1979–1990 and 1991–2006 and (b) 1979–1994 and 1995–2006.

[8] An alternative specification was tested, where this variable was coded 1 if Democrats controlled both the state house and the governorship and 0 otherwise. It also returned insignificant results for the party control variable.

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