**Regulatory Externalities as a Driver of Corporate Environmental Performance**

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**ABSTRACT**

We hypothesize that regulatory externalities (i.e., regulations in jurisdictions beyond where a firm operates) can influence a firm’s environmental behavior. Specifically, we predict that firms will be sensitive to regulations both in neighboring jurisdictions and in jurisdictions where peer firms operate. By examining the use of renewable-generating technologies in the U.S. electrical utility sector between 2001 and 2006, we find evidence of regulatory externalities while controlling for firm capabilities and regulations within the jurisdictions where a firm operates. Firms adopt more renewable power generation when their peers face greater renewable power standards elsewhere. Thus, in the electrical utility sector, we find that regulatory externalities spur a race to the top.

**INTRODUCTION**

It is well documented that regulation and firm capabilities shape firms’ corporate environmental actions (Delmas, Russo, and Montes-Sancho, 2007; Henriques and Sadorsky, 1999; Karpoff, Lott, and Wehrly, 2005; Klassen and Whybark, 1999). We propose that, in addition to these effects, firms’ environmental actions are shaped by regulatory externalities (i.e., regulations outside of jurisdictions where they operate). Therefore, we argue that regulatory externalities can be an important determinant of firms’ environmental actions.

Specifically, we predict that firms are more likely to undertake environmentally responsible actions when neighboring jurisdictions require such actions. Geographic regions tend to share common economic and social values, and firms are cognizant that these external pressures can foreshadow novel environmental regulatory demands. Responding to policy set outside a firm’s jurisdiction can allow a firm to better position itself in the market for the requisite resources to improve its environmental performance. For example, Oklahoma Gas & Electric, a major investor-owned utility, has been active in sourcing wind-generated electricity, despite not facing a Renewable Portfolio Standard (RPS) in either Oklahoma or Arkansas, the two states in which it operates. Nevertheless, its operational footprint is located in the Southwest and is contiguous to the states of Texas, New Mexico, and Colorado, all of which have adopted increasingly stringent RPS policies.

We also predict that firms undertake environmentally responsible actions when other firms within their regulatory jurisdiction (what we refer to as peer firms) face demanding policies elsewhere. These differentially regulated peers can both affect what is deemed as a legitimate business practice and shape the expectations of external stakeholders, including the public, policy makers, and special-interest groups. Operating within a common jurisdiction with such peer firms creates a degree of expediency that would not otherwise persist. For example, in Minnesota, five investor-owned electric utilities provide energy to final consumers. Of these utilities, two operate only in Minnesota. However, two utilities also operate in two other states, and one operates in five other states. Because each state maintains its own independent environmental policy that can shape firm action, changes in regulatory obligations faced by the firms operating in multiple states might influence those firms’ actions in Minnesota. Any such changes in the firms’ actions, in turn, can shape the practices adopted by peer firms in Minnesota, which may face greater external pressure to change their environmental activities if some firms have adopted different environmental standards to meet regulations set in other states.

Our empirical examination focuses on renewable energy use by investor-owned utilities (IOUs) in the United States between 2001 and 2006. The U.S. electric utility sector, which represents one of the largest emitters of carbon dioxide, has faced mounting pressure from state- and federal-level policy makers to adopt new power generation technologies. Over the period of our study, renewable power generation had grown by more than 12%. Previous research has identified the effects of firm and institutional factors on renewable energy generation by IOUs (Delmas *et al.*, 2007; Sine and Lee, 2009). The regulatory policy that we observe is the state-level RPS that mandates the use of renewable power by IOUs. These policies vary widely across states and, in some cases, vary within a state as regulators have chosen to intensify the demands on utility firms. Moreover, the electric utility sector comprises many firms with single-state operations and other firms with operations that span multiple states.

As predicted, we find that as peer firms’ exposure to stringent environmental policy increases, a focal firm increases its use of renewable power. However, we find that when neighboring states adopt a more stringent RPS, firms reduce their renewable energy use. Our results not only highlight that firms’ environmental actions are sensitive to the regulatory policies outside their jurisdictions, they suggest that peer firms are an important conduit for the dissemination of environmental actions across jurisdictions. We demonstrate these effects while reconfirming previous findings that state RPS policies and firm capabilities affect the use of renewable power (Yin and Powers, 2010; Delmas *et al.*, 2007; Lyon and Yin, 2007).

The next section provides background and develops our hypotheses. We then discuss the sample, describe the empirical approach, and interpret the results. The final section offers implications for firm strategy and public policy.

**Regulatory externalities**

A complication when assessing the impact of public policy on corporate environmental actions is that policies often differ across jurisdictions. Jurisdictions exist not only at the national but also at the sub-national level. We argue that regulations in one jurisdiction have the potential to affect firms in other jurisdictions, thus creating a regulatory externality.

Existing research recognizes the possibility of regulatory externalities. The pollution haven hypothesis is a much deliberated case of such an externality that influences corporate environmental performance (Copeland and Taylor, 1994; Rugman and Verbeke, 1998; Revesz, 1992; Christmann and Taylor, 2001). According to this hypothesis, pollution-intensive operations will migrate to jurisdictions with lax environmental standards. Despite being cogently and persuasively argued, this ‘race-to-the-bottom’ argument has faced a mounting body of disconfirming empirical evidence (Lucas, Wheeler, and Hettige, 1992; Grossman and Krueger, 1993; Rugman, Kirton, and Soloway, 1999; Levinson and Taylor, 2008).

According to another body of work, when firms locate in areas with lax regulation, the result can be regulatory competition across jurisdictions. For example, the empirical finance and law literature has presented a similar argument concerning a ‘Delaware effect,’ where competition between states for corporate chartering and tax revenue leads to deterioration in corporate standards (Bebchuk, 1992). Bebchuk and Cohen (2003) find that a state’s decision to add an antitakeover statute—a measure recognized as detrimental to shareholder value—can significantly increase a state’s ability to retain local firms and attract out‐of‐state incorporations.

Our focus (although related) addresses a different question. We examine how firm actions within a jurisdiction are affected by regulations in jurisdictions where a firm does not have operations. We propose this influence is a result of two effects.

*Neighboring jurisdiction effect*

Regulatory policy adopted in nearby jurisdictions can shape firm actions because environmental concerns are often geographically shared and regional policy makers are likely to be associated with one another. A state’s membership in a regional organization or a state’s geographic proximity can lead to expansive policy making where an initiative spreads throughout a region. Therefore, environmental policy set in a nearby jurisdiction can have implications for the market for requisite resources to respond to that policy.

Firms that act on the presence of a regulatory externality from a neighboring jurisdiction can undertake efforts to preempt that policy by improving their environmental performance. Such as response is illustrated by Idaho Power’s 2010 update of its environmental initiatives. Idaho Power cites how the proliferation of RPS policies in the region increased the overall demand for renewable power in its neighboring states. Despite these concerns and despite not being statutorily required to do so, Idaho Power has actively pursued the renewable energy market, by securing wind power from six different projects in Idaho, Montana, and Oregon.

Acting on the expectation of policy reform in nearby jurisdictions is consistent with formal and anecdotal evidence of policy preemption (Maxwell and Decker, 2006; Maxwell and Lyon, 2004). Firms may choose to enhance their environmental performance in an effort to forestall novel regulations (King and Lenox, 2000; Rivera and de Leon, 2004). Moreover, preemption might not only displace more stringent policy types but also act as a market-based response to developments in nearby jurisdictions. By adopting more stringent policies from neighboring jurisdictions, a firm can act as a supplier to customers or other firms in the neighboring jurisdiction that are statutorily required to source such goods.

For the above reasons, the neighboring jurisdiction effect leads to the following hypothesis.

*H1: The more stringent the environmental policies in states contiguous to where a firm operates, the better a firm’s environmental performance.*

*Peer effect*

We also expect that firms’ environmental performance is heightened when peer firms (i.e., firms that operate in the same jurisdiction) operate in other jurisdictions with more stringent environmental policies. Two arguments lead to this prediction.

First, firms that operate in multiple jurisdictions tend to adopt stringent operating procedures across their operations rather than conforming to the standard in each jurisdiction. Eskeland and Harrison (2003) note that multinational firms in potential pollution havens are significantly more environmentally friendly than indigenous firms. This finding is consistent with the technology transfer literature, which finds that multinationals tend to use the same or similar technologies in developing countries as in their home country (see Caves, 1996, for a review). A key consideration is the difficulties of managing different technologies across geographies (e.g., King and Shaver, 2001); therefore, a more efficient approach is for firms to adopt a consistent stringent operating procedure rather than adapting operating procedures to each jurisdiction. For example, Northern States Power, an electric utility that serves customers in five states in the upper Midwest United States, maintains a consistent operating procedure with respect to the provision of renewable energy and energy-efficiency programs, despite significant variation in environmental requirements across jurisdictions. This firm’s efforts include investment in a large-scale wind project in North Dakota, where the firm has no statutory responsibility to provide renewable power.

Second, firms face pressures to increase their environmental performance when their peer firms operate in jurisdictions with more stringent environmental policies. As we noted above, these peer firms likely adopt more stringent environmental standards than required within the jurisdiction. A firm that does not match this higher performance can be exposed as having inferior performance, thereby subjecting it to pressure from various stakeholders (Henriques and Sadorsky, 1999; Bansal and Roth, 2000). Awareness of variation in regulatory obligations can drive interfirm rivalry in a manner analogous to changes to the relative strength between firms or the introduction of new entrants to a market (Chen, Su, and Tsai, 2007). Moreover, policy makers within the jurisdiction might be more willing to choose more stringent standards because they know that the peer firms will be able to adapt and will not be out of compliance under more stringent standards (Fremeth, 2009). In Idaho, a state that has yet to adopt an RPS, the policy debate has considered the relative RPS obligations faced by utilities that also operate in other jurisdictions and the resulting implications of these obligations on Idaho’s renewable energy market.

Combined, these arguments lead to the following hypothesis.

*H2: The more stringent the environmental policies faced elsewhere by other firms within a jurisdiction, the better a firm’s environmental performance.*

**METHODOLOGY**

**Empirical context and data**

The empirical setting for our analysis is the U.S. electric utility sector. Firms within this industry represent some of the country’s biggest polluters, which contributed approximately 40% of the country’s total carbon dioxide emissions in 2008 (Energy Information Administration, 2011). We focus on the choice by investor-owned utilities (IOUs) between 2001 and 2006 to source renewable power (i.e., biomass, waste, geothermal, tidal, hydroelectric, solar, and wind power) to distribute to customers. IOUs are the largest players in the U.S. electrical utility industry and have discretion over of the source of the electricity they sell to final customers.

Within this industry, states have adopted regulatory policies of varying strengths to induce the use of renewable power. The policies we focus on are RPS objectives that compel IOUs to include a specified percentage of renewable power in the mix of energy they sell. These policies vary significantly across states.[[1]](#footnote-1) For example, Arizona’s RPS requires 1.1% of energy to be from renewable sources, whereas Minnesota’s requires 30% for its largest IOUs. Furthermore, as of 2006, 29 states did not have an RPS policy.[[2]](#footnote-2)

Our sample is based on all IOUs in the United States, which consists of 132 firms operating in every state except Alaska and Nebraska, where electricity is provided by public authorities and rural cooperatives. The electric utilities in our sample generate and/or purchase power that provides approximately 85% of the country’s total electricity. This is a stable industry that includes many firms with historical roots dating to the electrification of the country during the late 19th century. As a result, we do not observe IOUs entering into new markets over the six-year period of our study. Nonetheless, IOUs have expanded their operational footprint into new states through merger and acquisition activity.[[3]](#footnote-3) From the population of 132 firms, we excluded five IOUs in Texas because of our inability to assess their mix of energy types. Omitting these five firms left a usable sample of 127 firms.

To construct the requisite variables, we sourced information from a series of privately and publicly available databases. The primary source was a dataset provided by Platts, an electric industry consulting firm, which documented firms’ power-generation statistics and purchase contracts with independent power producers (IPPs). Platts is a leader in this industry and lists among its clients many IOUs, institutional investors, and banks. We gathered IPPs’ data from the U.S. Environmental Information Administration, the Federal Energy Regulatory Commission’s Form 1 dataset, Utilipoint (an electric industry consulting firm), Energy and Environmental Analysis (a consulting company), Combined Heat and Power sources database, and the American Wind Energy Association. The U.S. Department of Energy’s office of Energy Efficiency and Renewable Energy provided data on state renewable energy policies. We sourced other state variables from the Congress of State Government’s Book of the States, the U.S. Bureau of Economic Analysis, the Sierra Club of America, and the Department of Energy.

**Variable definitions**

*Dependent variable*

We examine the total renewable power *distributed* to the end consumer, which includes power generated by the IOU and purchased from IPPs. Although consistent with the existing literature, the inclusion of IPP power deviates from the common approach of focusing only on IOU renewable power-generating capacity (Delmas *et al.*, 2007; Sine and Lee, 2009). We favor measuring total power distributed because our predictions concern firms’ environmental performance, which is a function of both what an IOU generates and what it sources from IPPs. We calculate the variable PERCENT\_RENEWABLESit as the share of total power sold by IOU *i* in year *t* from wind, solar, hydro, biomass, and geothermal generating sources.

*Independent variables*

*Neighboring Jurisdiction Effect.* We code a variable to identify the stringency of the RPS policies in states contiguous to where a focal firm operates. NEIGHBOR\_EFFECTit is the average RPS objective of the contiguous states where the focal firm does not have any operations. The average number of contiguous states for multi-state utilities is 6.6 with a maximum of 11 states. The average for single-state utilities is 3.9 states with a maximum of 7.

*Peer Effect.* We calculate the variable PEER\_EFECTit as the average RPS faced by all other IOUs that operate in the same state(s) as a focal firm. For example, Oklahoma Gas & Electric operates in Oklahoma and Arkansas and has five peer firms in those two states that also operate elsewhere. We measure the RPS objective that each peer is obligated to meet. When a peer is a multi-state utility, we measure its RPS objective as the highest policy that it faces across its multiple states. We then take the average of the RPS for all peers and assign that number to a focal IOU.

*Control Variables*

Many other factors potentially affect firms’ environmental performance. For this reason, we include a number of firm and state controls.

*Firm controls.* Many IOUs face statutory requirements for renewable energy in the states in which they operate. HOME\_RPSit measures the percentage of renewable power required by RPS objectives where a firm operates. For multi-state utilities, we calculate a weighted average that is based on the electricity sold in each state. We assign this variable the value of zero for IOUs that face no RPS requirement.

We calculate the variable OPERATIONAL\_CAPABILITYit to control for the possibility that firms differ in the organizational systems required to meet regulatory demands. To capture the aptitude of IOUs in responding to an RPS, we created a time-varying measure that represents the operational expertise of a firm to manage a diverse fuel mix by calculating a Hirschman-Herfindahl Index (HHI) of the fuel mix–diversity of an IOU *i* in year *t*. We expect firms with greater fuel mix are better able to comply with RPS standards (Fremeth, 2009). Because lower concentration of fuel mix represents a greater HHI, we multiplied this measure by negative one and expect OPERATIONAL\_CAPABILITY to have a positive effect.

We also controlled for firm size with the expectation that larger IOUs might also have more technology options available because they tend to have sophisticated operations and are required to meet growing demand. The variable FIRM\_SIZEit measures a firm’s total electricity sales in megawatt hours (MWh) in a given year.

Because consumers can be an important driver of whether a firm chooses to improve its environmental performance, we include the variable RESIDENTIAL\_SALESit, which we define as the percentage of an IOU’s sales that are made to residential customers. We also control for INDUSTRIAL\_SALESit, which we define as the percentage of an IOU’s sales that are made to industrial customers as a percentage of the firm’s total sales. Industrial consumers are particularly sensitive to increases in electricity pricing that are likely to result from the adoption of renewable power.[[4]](#footnote-4)

Because information can embolden opposing groups or provide public relations opportunities, we capture differences in firms’ reporting of their environmental performance. VOLUNTARY\_REPORTINGit is a dummy variable identifying firms that participated in the U.S. Department of Environment’s 1605(b) program of voluntarily reporting greenhouse gas (GHG) emissions. This federal program provided utility firms the option to self-disclose estimates of their emissions. INVOLUNTARY\_REPORTINGit is a dummy variable identifying firms required to reveal generating technologies due to state mandates. This information is disclosed periodically on websites, in annual reports, and in notices enclosed with monthly utility bills.

*State controls.* We include the variable DEREGULATIONit to account for whether an IOU operates in a state that has undergone market deregulation. We also include the variable NUCLEAR\_MORATORIUMit to capture states that have a moratorium on new nuclear-generating plants. For multi-state utilities, we weight both variables by the percentage of sales in each state. We expect both variables to be positively related to an IOU’s use of renewable power because these variables shape the choices of energy generation technologies available to IOUs.

We also control for the state operating environment in two ways. First, we include state carbon dioxide emissions in metric tons per state capita (CO2\_EMISSIONSit). To further evaluate the industrial concern with renewably generated, higher priced power, we include MANUFACTURERSit, which is the percentage of the state gross state product (GSP) from the manufacturing sector. In both cases, we calculate weighted averages on the basis of the firms’ state sales for multi-state utilities.

We include the variable DEMOCRATSit to capture the political leaning of a state in which an IOU operates. The variables take the value 1 if the Democratic Party both holds a majority in the state legislature and controls the governor’s office. We include the state budget in millions per capita in the variable BUDGETit to control for the possibility that affluent states are better able to afford to make more stringent renewable energy policy and pay the premium for such power.

The presence of environmentalist groups in a state can also shape firm behavior. We include SIERRA\_CLUBit which is the per capita state membership in the Sierra Club to operationalize the influence of the environmental lobby.

Finally, we include two variables that capture the preferences and competences of state public utility commissions (PUCs). PUC\_TENUREit captures the average years of experience of the commissions that an IOU interacts with. More experienced commissions hold greater tacit knowledge of the operational competences of the firms that they regulate and tend to provide more consumer friendly policies (Fremeth and Holburn, forthcoming). ELECT\_PUCit identifies PUCs that are directly elected by the public. PUCs that are directly elected are more responsive to consumer interests because of their concern with re-election (Zelner, 2001; Bonardi, Holburn, and Vanden Bergh, 2006). These state-specific variables are weighted by an IOU’s state sales to account for multi-state utilities.

Table 1 presents descriptive statistics and Table 2 provides the correlation matrix for these variables.

[Place Table 1 about here.]

[Place Table 2 about here.]

**Estimation**

We test our predictions using a dynamic panel estimator. We chose this approach for the following reasons: the panel data has few years (6 years) and many firms (127 firms), we predict linear relationships, the dependent variable is likely dependent on its past realizations (i.e., the current proportion of renewable power is contingent on the past proportion of renewable power), the independent variables are possibly correlated with past and current realizations of the error term (i.e., the fuel mix diversity is predetermined and not strictly exogenous), we want to control for potential unobserved firm effects, and we are concerned with heteroscedasticity and autocorrelation in the panel.

These econometric issues are addressed by the Arellano-Bond (Arellano and Bond, 1991) general method of moments (GMM) estimator. We estimate the following two equations:

PERCENT\_RENEWABLESit=β1PERCENT\_RENEWABLESit-1+ β2NEIGHBOR \_EFFECTit + β3PEER \_EFFECTit + Xit + µit (1)

µit = vi +eit (2)

As represented in equation 1, in addition to the hypothesized effects, we include a one-year lag of the dependent variable because prior adoption of renewable energy can be an important driver of future dependence on such technologies. These prior choices may be realized only in future time periods when utility firms improve their productivity, embrace the choices with greater commitment, or complete multi-stage investment projects.[[5]](#footnote-5) In this equation, Xit represents the remaining control variables that are included in the model. We include all previously described control variables and the interaction of HOME\_RPSit and OPERATIONAL\_CAPABILITYit because an IOU’s choice to improve its environmental performance may be jointly determined by environmental policy and operational competence (Fremeth, 2009). As noted in equation 2, the error term in equation 1, µit**,** can be decomposed into the unobserved firm-specific effects, vi, and the observation specific error, eit.

We employ the ‘difference’ variant of the GMM estimator that uses internal instruments in estimation following a first differencing of the data (Holtz-Eakin, Newey, and Rosen, 1988). These internal instruments are built from past observations of the variables and are valid when uncorrelated with future error terms but highly correlated with the variable that is being instrumented. The result is a series of moment conditions that are met when a zero correlation exists between the instrumenting variables and the error term. Two moment conditions are listed in equations (3) and (4).

(3)

(4)

In our model, we considered all firm-specific variables as endogenous and all state-specific factors as exogenous. The instruments used are the second lag of the endogenous variables and their own values for the exogenous variables. The endogenous variables are instrumented in this manner because the second lag is not correlated with the current error term, whereas the first lag is. According Roodman (2009), this treatment is the standard for instrumental variables in the difference GMM approach. The number of instruments used is listed with the results. Year dummies are included to control for temporal effects and to ensure no correlation across firms in the error term, which is necessary for the autocorrelation test (Roodman, 2009). Further, we focus on the results using the two-step robust estimator that corrects panel-specific autocorrelation and heteroscedasticity, as developed by Windmeijer (2005). To assess whether the instruments are exogenous and to ensure the validity of the GMM estimates, we rely on the Hansen J-test.

**RESULTS**

Table 3 presents the results of the GMM regressions that assess renewable power use by IOUs between 2001 and 2006. The Hansen J-test statistic for overidentifying restrictions is not significant for all models. As a result, we cannot reject the null hypothesis that the overidentifying restrictions are valid and, thus, conclude that the instrumental variables are not correlated with the error term. Further, the difference in Hansen tests of exogeneity (which compares full and restricted models to assess the orthogonality of the instruments), also referred to as the C statistic, was not significant. This result further supports the adopted approach. Finally, the test for autocorrelation in the error structure is not significant for either first- or second-order autocorrelation, a finding consistent with the model’s assumption of no second-order autocorrelation, which may otherwise invalidate some lags as instruments. Together, the results of these specification tests lend confidence to our use of the GMM difference estimation approach.

[Place Table 3 about here.]

Before, interpreting the hypothesis tests, we wanted to confirm that capabilities and environmental policies affect firms’ environmental performance, which allows us to verify the consistency of our data with existing research and forms a basis from which to examine the effects of regulatory externalities. Model 1 in Table 3 confirms this expectation. The coefficient estimates of OPERATIONAL\_CAPABILITY, HOME\_RPS and their interaction are positive and statistically significant (*p* < 0.01). The marginal effect of an RPS policy on changes to renewable power ranges from –0.09% when the compliance capability measure is at the minimum (i.e., least fuel diversity) to 1.04% when at its maximum.[[6]](#footnote-6) The marginal effect for the average firm (OPERATIONAL\_CAPABILITY = –9.02) is 0.09.

Turning to the hypothesis tests, we chose to initially present the results of NEIGHBOR\_EFFECT and PEER\_EFFECT separately because these variables are moderately correlated. Model 2 presents results from a specification that includes NEIGHBOR\_EFFECT. Model 3 presents results from a specification that includes PEER\_EFFECT. Model 4 presents results from a specification with both NEIGHBOR\_EFFECT and PEER\_EFFECT.

In model 2, we do not find support for hypothesis 1, which considered a firm’s sensitivity to policies set in neighboring jurisdictions. The estimate of NEIGHBOR\_EFFECT does not test differently from zero. Utility firms do not appear to alter their use of renewable power when neighboring jurisdictions increase RPS requirements.

Model 3, however, shows support for hypothesis 2. The positive and statistically significant (*p* < 0.01) coefficient of PEER\_EFFECT demonstrates that firms increase their use of renewable power as their peers are subject to increasingly stringent RPS policies elsewhere. This finding is consistent with the existence of a regulatory externality.

Model 4 includes NEIGHBOR\_EFFECT and PEER\_EFFECT in the same specification. We find that PEER\_EFFECT remains positive and significant (*p* < 0.01). However, when controlling for the PEER\_EFFECT, we find that the coefficient estimate of NEIGHBOR\_EFFECT is negative and statistically significant (*p* < 0.05). Therefore, beyond utility firms improving their environmental performance in response to the regulatory externality induced by peers, these firms appear to curb such actions when pressure emanates from neighboring jurisdictions.

Because previous studies have identified the importance of regulation and competence at improving environmental performance, it is worthwhile interpreting the effect of regulatory externalities vis-à-vis these established relationships. The economic significance of PEER\_EFFECT is considerable. The coefficient of peer effect indicates that a 1% increase in RPS faced by peers increases a focal firm’s use of renewable power by 0.24%. Recall, when a state’s RPS increases by 1%, a firm of average compliance capability increases renewable power generation by only 0.09%, or one-third the magnitude. For the most capable firms, the effect of the focal state’s RPS exceeds that of the peer’s RPS (1.11% versus 0.24%). Although the focal effect is larger than the peer effect, the magnitude of both effects highlights the significance of the peer effect. For an average-sized utility, a unit increase to PEER\_EFFECT is equivalent to powering 3,800 homes with renewable power for one year.

The finding of a negative relationship from the NEIGHBOR\_EFFECT is unexpected; however, its economic significance is relatively modest. An increase in a neighboring state’s RPS by 1% decreases a firm’s renewable power use by 0.05%. Our interpretation of the negative effect is that the adoption of an RPS in a nearby jurisdiction can induce a premium in the marketplace for renewable power. Holding all other factors constant, this effect might encourage firms to relinquish the amount of renewable power they source if the increased demand for this power becomes more expensive. Therefore, firms in neighboring jurisdictions might substitute more traditional forms of electricity generation.

Turning to the control variables, several estimates were consistent throughout the models and are consistent with results in the existing literature. The coefficient of the lagged dependent variable is positive and statistically significant (*p* < 0.01) for all models.[[7]](#footnote-7) This finding lends support to the expectation that current levels on renewable power are based on prior levels of its use. Thus, firms experienced with new generating technologies are likely to seek out these options in the future. Related to this interpretation is that renewable energy projects are often multi-stage investments that come online over several years.

Interest group pressure has diverging effects on renewable power use as the coefficient estimate for RESIDENTIAL\_SALESit is negative and marginally significant (*p* < 0.10), whereas the estimate for SIERRA\_CLUBit is positive and significant (*p* < 0.01). Therefore, firms that have greater ties to residential customers use less renewable power, which tends to be more expensive on a kilowatt-hour basis. Firms in jurisdictions with a stronger environmental lobby are likely to enhance their environmental performance, consistent with Sine and Lee (2009) and Maxwell *et al.* (2000). We also find that larger firms are less likely to adopt renewable power because the coefficient estimate for FIRM\_SIZEit is negative and marginally significant (*p* < 0.10). This finding is consistent with the interpretation that larger firms may be tied to the large-scale base load plants (i.e., nuclear and coal plants) and face considerable inertia in efforts to modify organizational practices. Consistent with Delmas *et al.* (2007), we find that DEREGULATIONit is positive and significantly related (*p* < 0.01) to use of renewable power. In fact, IOUs that operate in deregulated states tend to use approximately 5% more renewable power. The coefficient for DEMOCRATSit is positive and significant (*p* < 0.05), indicating that firm choice to modify its environmental performance is sensitive to the political landscape. Year dummies are included in all models; although not reported in the tables, we find a positive and significant (*p* < 0.01) estimate for 2005. This estimate might be due to the passage of The Energy Policy Act of 2005 that allocated $2.7 billion to extend the renewable electricity production credit program.

*Robustness tests and alternative explanations*

We assessed whether our results were sensitive to different operationalizations of our key variables by re-estimating the models with a different measure of PEER\_EFFECTit. Instead of using the most stringent RPS, the modified measure used a weighted average RPS faced by peer firms (based on the quantity of power in megawatt hours sold in each state), before averaging across a focal firm’s peers. Similarly, we estimated the models with an alternative to NEIGHBOR\_EFFECTit. This modified measure calculated the average RPS objectives for the states contiguous to the state where a focal firm had more than 50% of its retail sales. This model was based on the logic that firms would be most sensitive to outside pressures on their key market. In both statistical and economic significance, our results were robust and supported inclusion of these variables as substitutes for the two variables of interest.

Next we considered whether the identified relationships were driven by states with weak RPS pulling down environmental performance. To assess this effect, we estimated models that examined whether the PEER\_EFFECT or NEIGHBOR\_EFFECT was greater than the focal firm’s exposure to an RPS. To do this, we included dummy variables that indentified whether a focal firm’s RPS obligations were less than that of its peers, PEER\_RPS>FOCAL\_RPSit, or less than that of the neighboring jurisdictions, NEIGHBOR\_RPS>FOCAL\_RPSit. Table 4 presents these results. The estimated coefficients on these two dummy variables are statistically significant (*p* < 0.01) and consistent with the results in Table 3. When the focal firm’s RPS exposure is less than that of its peers, the firm increases its use of renewable power. Although, when the RPS in neighboring states is greater than a firm’s own regulatory obligations, the firm then reduces its use of renewable power. Therefore, firms appear to be most likely to adjust their strategy when the regulatory externality creates a deficit between their own statutory obligations and those set elsewhere. In particular, the finding on the PEER\_RPS>FOCAL\_RPSit variable lends further support to the argument that regulatory externalities lead to a ‘race to the top.’ Firms that are less stringently regulated respond by improving their environmental performance when their peers are more stringently regulated elsewhere.

[Place Table 4 about here.]

Because renewable resources are not distributed uniformly in the United States, an alternative explanation is that access to renewable resources correlates with our regulatory externality measures. We do not believe that this alternative explanation drives our results for the following reasons. First, multiple sources of renewable power exist in almost every state (Farrell and Morris, 2010). Second, our GMM estimator accounts for firm-specific factors, such as location. Third, utility firms are able to purchase renewable power from sources outside their operational footprint. For example, Indianapolis Power and Light has a 20-year agreement to purchase wind power from a source 700 miles away, in southwestern Minnesota. Similar purchase arrangements have become commonplace in this sector and have created geographical diversity to a firm’s generation base.

Another alternative explanation that leads from the previous discussion is the possibility that, rather than recording actual changes in renewable power, we are capturing a trend toward purchased power arrangements—of which renewable power comprises an increasingly large proportion. As a result, we re-estimated the models to assess whether our regulatory externality variables explain this broader phenomenon in the electric utility sector. We are interested in whether environmental regulation in other jurisdictions influences a firm’s choice to procure power as part of its total supply. We use the ratio of a firm’s total purchased power in MWh to its total power sold as the dependent variable. We estimate the same specification as that in model 4 and the results are found in Table 5. The coefficient estimates of the PEER\_EFFECT and NEIGHBOR\_EFFECT are both not statistically significant. Therefore, this finding lends further confidence to our argument that regulatory externality shapes environmental performance and not to a broader trend that may be spuriously correlated with our variable of interest.

[Place Table 5 about here.]

**DISCUSSION AND CONCLUSION**

We demonstrate that firms modify their environmental performance when policies set in other jurisdictions affect the operations of their peers. We find this while controlling for the effects of firm capabilities and local regulation. This regulatory externality is a by-product of the proliferation of environmental policies that have developed at national and sub-national levels.

Although the size of the peer effect demonstrates its significance, the divergence between the peer effect and the neighboring jurisdictioneffectemphasizes that the primary mechanism for the externality occurs through peer firms. Peer firms provide an accessible, relative comparison for how firms can be regulated and expected to perform. The effect of peer firms represents a novel explanation for the capacity of market and competitive dynamics to shape the diffusion of policy requirements across borders. The process of policy diffusion has been established in the political science literature, where it has emphasized the potential for policy makers to learn from nearby or similar jurisdictions (Volden, Ting, and Carpenter, 2008), respond to economic competition (Shipan and Volden, 2008), and react to coercive pressure (Henisz, Zelner, and Guillen, 2005).Yet, the role of differentially regulated firms has been understated, their impact on other firms in a common jurisdiction has not been explicitly considered (see Schwarcz, 2010, for a discussion in the insurance industry). Although we do not observe whether policy makers undertook reforms after firms in their jurisdiction became more stringently regulated elsewhere, we identify that firms in the state modified their actions to improve their environmental performance when their peers faced more stringent policies elsewhere. This effect identifies that the policy itself does not need to diffuse across political actors to have impact across jurisdictions.

Nevertheless, our theory and findings have implications that extend beyond firms and to policy makers. Regulatory spillovers continue to take on greater relevance as governments adopt policies of varying stringencies. Our findings suggest that when such regulations affect firms that either operate in multiple jurisdictions or compete with other firms located in multiple jurisdictions, policy makers must be cognizant that firm actions can spread policies beyond the direct effect of regulation. Although we focus on environmental outcomes, similar effects might exist over policy arenas such as labor regulation, product safety, and intellectual property. Policies set without the explicit recognition of regulatory spillovers might not have the desired outcome.

Within the context of our study, rather than leading to a race to the bottom, regulatory differences across jurisdictions lead to a race to the top. We found firms adopting more stringently environmental practices when their peers face such regulations elsewhere. We did not find evidence of firms increasing polluting activities in less stringently regulated jurisdictions. Our finding suggests an interesting direction for work that has begun to identify these races to the top (Revesz, 1992; Vogel, 1995; Daines, 2001; Baldwin and Krugman, 2004) by emphasizing the intermediary role played by firms and competitive dynamics. Understanding the implications of regulatory competition between jurisdictions, therefore, requires analysis of the firms that compete in those jurisdictions and how they may be regulated elsewhere.

Future research can also further develop this concept by examining whether the extraterritorial pressure can motivate firms to undertake other strategic moves. Such an analysis may include choosing to enter or exit a particular jurisdiction on the basis of the varying regulatory obligations of the peer firms located in those jurisdictions. For example, disparities in regulatory demands and the accompanying competences in meeting them can present profitable opportunities that drive firm entry. Alternatively, firms may choose to intervene in the political markets of jurisdictions where they have little to no operational footprint to not only shape the regulatory obligations of their peers but to also either establish or neutralize a regulatory externality. Subsequent work could also examine differences between those firms that are establishing the externality for others (i.e., firms that are regulated more stringently elsewhere) and those firms that act as recipients of such pressure (i.e., firms that share a jurisdiction with the other firm). We have only begun to consider these differences but substantial scope remains to examine divergences in the strategic actions taken by these distinct actors and whether particular firm characteristics predispose some firms to being more apt to respond to a regulatory externality.

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Table 1. Descriptive statistics

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Variable** | **Mean** | **Standard Deviation** | **Minimum** | **Maximum** |
| PERCENT\_RENEWABLESit | 6.441 | 11.435 | 0.000 | 72.000 |
| HOME\_RPSit | 4.785 | 8.149 | 0.000 | 30.000 |
| OPERATIONAL\_CAPABILITYit | –9.015 | 1.475 | –10.000 | –3.954 |
| NEIGHBOR \_EFFECTit | 3.318 | 4.806 | 0.000 | 21.000 |
| PEER \_EFFECTit | 4.541 | 7.466 | 0.000 | 30.000 |
| RESIDENTIAL\_SALESit | 33.751 | 7.661 | 0.583 | 53.756 |
| INDUSTRIAL\_SALESit | 29.801 | 15.397 | 0.000 | 98.966 |
| MANUFACTURERSit | 0.007 | 0.009 | 0.000 | 0.092 |
| FIRM\_SIZEit | 18.662 | 19.850 | 0.061 | 103.653 |
| DEREGULATIONit | 0.449 | 0.490 | 0.000 | 1.000 |
| VOLUNTARY\_REPORTINGit | 0.627 | 0.484 | 0.000 | 1.000 |
| INVOLUNTARY\_REPORTINGit | 0.572 | 0.473 | 0.000 | 1.000 |
| CO2\_EMISSIONSit | 11.335 | 10.989 | 0.016 | 102.569 |
| SIERRA\_CLUBit | 20.160 | 29.348 | 0.711 | 198.590 |
| NUCLEAR\_MORATORIUMit | 0.348 | 0.457 | 0.000 | 1.000 |
| DEMOCRATSit | 0.340 | 0.455 | 0.000 | 1.000 |
| BUDGETit | 0.003 | 0.004 | 0.000 | 0.024 |
| PUC\_TENUREit | 4.160 | 2.433 | 0.333 | 14.667 |
| ELECT\_PUCit | 0.128 | 0.320 | 0.000 | 1.000 |

Table 2. Correlation matrix

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Variables** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **12** | **13** | **14** | **15** | **16** | **17** | **18** |
| **1** | PERCENT\_RENEWABLESit | 1.00 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **2** | HOME\_RPSit | 0.31 | 1.00 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **3** | OPERATIONAL\_ CAPABILITYit | 0.46 | 0.33 | 1.00 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **4** | PEER \_EFFECTit | 0.33 | 0.55 | 0.34 | 1.00 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **5** | NEIGHBOR \_EFFECTit | 0.08 | 0.40 | 0.10 | 0.41 | 1.00 |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **6** | RESIDENTIAL\_SALESit | 0.03 | 0.07 | 0.05 | 0.07 | 0.16 | 1.00 |  |  |  |  |  |  |  |  |  |  |  |  |
| **7** | INDUSTRIAL\_SALESit | –0.03 | –0.16 | –0.04 | –0.15 | –0.25 | –0.63 | 1.00 |  |  |  |  |  |  |  |  |  |  |  |
| **8** | MANUFACTURERSit | –0.08 | –0.05 | –0.08 | –0.04 | 0.04 | –0.01 | 0.01 | 1.00 |  |  |  |  |  |  |  |  |  |  |
| **9** | FIRM\_SIZEit | –0.04 | –0.06 | –0.02 | –0.08 | –0.05 | 0.04 | –0.09 | 0.18 | 1.00 |  |  |  |  |  |  |  |  |  |
| **10** | DEREGULATIONit | –0.07 | 0.25 | –0.07 | 0.27 | 0.35 | 0.18 | –0.24 | 0.01 | 0.00 | 1.00 |  |  |  |  |  |  |  |  |
| **11** | VOLUNTARY\_REPORTINGit | –0.27 | –0.17 | –0.29 | –0.19 | –0.05 | 0.00 | 0.06 | 0.14 | 0.35 | 0.02 | 1.00 |  |  |  |  |  |  |  |
| **12** | INVOLUNTARY\_REPORTINGit | 0.08 | 0.31 | 0.12 | 0.29 | 0.27 | 0.30 | –0.31 | –0.05 | 0.08 | 0.36 | –0.05 | 1.00 |  |  |  |  |  |  |
| **13** | CO2\_EMISSIONSit | –0.22 | –0.19 | –0.24 | –0.18 | –0.15 | –0.11 | 0.19 | 0.72 | 0.11 | –0.28 | 0.13 | –0.35 | 1.00 |  |  |  |  |  |
| **14** | SIERRA\_CLUBit | 0.13 | 0.23 | 0.19 | 0.18 | 0.12 | 0.11 | –0.19 | –0.03 | 0.35 | 0.18 | 0.02 | 0.40 | –0.22 | 1.00 |  |  |  |  |
| **15** | NUCLEAR\_MORATORIUMit | 0.24 | 0.23 | 0.25 | 0.24 | 0.09 | –0.02 | –0.07 | 0.02 | –0.11 | 0.17 | –0.12 | 0.14 | –0.04 | 0.16 | 1.00 |  |  |  |
| **16** | DEMOCRATSit | 0.06 | 0.19 | 0.08 | 0.18 | 0.10 | 0.03 | –0.08 | 0.01 | 0.04 | 0.04 | 0.08 | –0.03 | –0.01 | 0.13 | 0.39 | 1.00 |  |  |
| **17** | BUDGETit | –0.04 | 0.14 | –0.03 | 0.15 | 0.27 | 0.09 | –0.17 | 0.70 | 0.06 | 0.17 | 0.11 | 0.12 | 0.36 | 0.02 | 0.25 | 0.14 | 1.00 |  |
| **18** | PUC\_TENUREit | 0.05 | –0.13 | 0.02 | –0.11 | –0.06 | 0.03 | 0.06 | –0.08 | 0.07 | –0.08 | 0.05 | –0.10 | 0.06 | –0.18 | –0.20 | 0.03 | –0.12 | 1.00 |
| **19** | ELECT\_PUCit | –0.09 | –0.14 | –0.11 | –0.13 | –0.07 | –0.03 | 0.00 | –0.11 | 0.03 | –0.25 | 0.09 | –0.31 | 0.09 | –0.19 | –0.22 | 0.22 | –0.10 | 0.38 |

Table 3. GMM regression models of renewable energy generated and purchased, 2001–2006

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | (1) | (2) | (3) | (4) |
| NEIGHBOR \_EFFECTit |  |  | –0.010 | –0.047\*\* |
|  |  |  | (0.025) | (0.023) |
| PEER \_EFFECTit |  | 0.236\*\*\* |  | 0.243\*\*\* |
|  |  | (0.069) |  | (0.073) |
| PERCENT\_RENEWABLESit–1 | 0.239\*\*\* | 0.239\*\*\* | 0.225\*\*\* | 0.240\*\*\* |
|  | (0.030) | (0.032) | (0.030) | (0.031) |
| HOME\_RPSit | 1.763\*\*\* | 1.517\*\*\* | 1.671\*\*\* | 1.564\*\*\* |
|  | (0.200) | (0.191) | (0.201) | (0.193) |
| OPERATIONAL\_CAPABILITYit | 7.301\*\*\* | 7.067\*\*\* | 7.278\*\*\* | 7.041\*\*\* |
|  | (0.444) | (0.459) | (0.437) | (0.445) |
| (HOME\_RPSit)\*(OPERATIONAL\_CAPABILITYit) | 0.186\*\*\*  (0.022) | 0.183\*\*\*  (0.023) | 0.180\*\*\*  (0.022) | 0.189\*\*\*  (0.023) |
| RESIDENTIAL\_SALESit | –0.596\*\* | –0.415\* | –0.598\*\* | –0.409\* |
|  | (0.241) | (0.226) | (0.243) | (0.231) |
| INDUSTRIAL\_SALESit | –0.071 | –0.056 | –0.070 | –0.053 |
|  | (0.083) | (0.081) | (0.082) | (0.079) |
| MANUFACTURERSit | 7.606 | –10.095 | 2.606 | –22.489 |
|  | (75.430) | (78.192) | (75.826) | (80.524) |
| FIRM\_SIZEit | –0.180\*\* | –0.139\* | –0.180\*\* | –0.139\* |
|  | (0.090) | (0.084) | (0.089) | (0.084) |
| DEREGULATIONit | 4.762\*\*\* | 4.773\*\*\* | 4.847\*\*\* | 4.700\*\*\* |
|  | (1.504) | (1.485) | (1.483) | (1.452) |
| VOLUNTARY\_REPORTINGit | –1.249 | –1.337 | –1.298 | –1.412 |
|  | (1.275) | (1.259) | (1.253) | (1.250) |
| INVOLUNTARY\_REPORTINGit | –0.172 | –0.163 | –0.181 | –0.124 |
|  | (0.402) | (0.417) | (0.400) | (0.413) |
| CO2\_EMISSIONSit | –0.008 | 0.007 | –0.003 | 0.019 |
|  | (0.068) | (0.070) | (0.069) | (0.073) |
| SIERRA\_CLUBit | 0.102\*\*\* | 0.074\*\*\* | 0.105\*\*\* | 0.083\*\*\* |
|  | (0.028) | (0.028) | (0.028) | (0.028) |
| NUCLEAR\_MORATORIUMit | 9.535 | 7.812 | 9.471 | 7.519 |
|  | (6.893) | (6.171) | (6.932) | (6.146) |
| DEMOCRATSit | 0.241 | 0.391 | 0.256 | 0.481\*\* |
|  | (0.253) | (0.248) | (0.239) | (0.237) |
| BUDGETit | –13.875 | –1.770 | –14.039 | –0.641 |
|  | (16.538) | (14.019) | (16.549) | (14.151) |
| PUC\_TENUREit | –0.029 | –0.011 | –0.029 | –0.005 |
|  | (0.027) | (0.027) | (0.027) | (0.027) |
| ELECT\_PUCit | –3.322 | –0.057 | –2.020 | 2.306 |
|  | (20.046) | (25.219) | (20.370) | (25.352) |
| Observations | 762 | 762 | 762 | 762 |
| Chi–Square | 8363.03\*\*\* | 8839.37\*\*\* | 8428.11\*\*\* | 9253.96\*\*\* |
| Instruments | 54 | 55 | 55 | 56 |
| AR(1) | –1.350 | –1.382 | –1.349 | –1.383 |
| AR(2) | –0.234 | –0.019 | –0.239 | –0.018 |
| Hansen J Test | 24.670 | 25.985 | 24.884 | 27.020 |

Notes:

Standard errors in parentheses

\* *p* < 0.10, \*\* *p* < 0.05, \*\*\* *p* < 0.01

Table 4. GMM regression models identifying source of regulatory externality

|  |  |
| --- | --- |
|  | (5) |
| NEIGHBOR \_EFFECTit | –0.028 |
|  | (0.028) |
| PEER \_EFFECTit | 0.142\* |
|  | (0.073) |
| NEIGHBOR\_RPS>FOCAL\_RPSit | –0.722\*\*\* |
|  | (0.274) |
| PEER\_RPS>FOCAL\_RPSit | 1.326\*\*\* |
|  | (0.491) |
| PERCENT\_RENEWABLESit–1 | 0.245\*\*\* |
|  | (0.031) |
| HOME\_RPSit | 1.629\*\*\* |
|  | (0.204) |
| OPERATIONAL\_CAPABILITYit | 7.078\*\*\* |
|  | (0.433) |
| (HOME\_RPSit)\*(OPERATIONAL\_CAPABILITYit) | 0.190\*\*\* |
|  | (0.024) |
| RESIDENTIAL\_SALESit | –0.342 |
|  | (0.221) |
| INDUSTRIAL\_SALESit | –0.007 |
|  | (0.069) |
| MANUFACTURERSit | –6.812 |
|  | (78.570) |
| FIRM\_SIZEit | –0.134\* |
|  | (0.081) |
| DEREGULATIONit | 4.279\*\*\* |
|  | (1.418) |
| VOLUNTARY\_REPORTINGit | –1.336 |
|  | (1.179) |
| INVOLUNTARY\_REPORTINGit | –0.193 |
|  | (0.381) |
| CO2\_EMISSIONSit | 0.006 |
|  | (0.071) |
| SIERRA\_CLUBit | 0.090\*\*\* |
|  | (0.032) |
| NUCLEAR\_MORATORIUMit | 8.407 |
|  | (6.211) |
| DEMOCRATSit | 0.422\* |
|  | (0.227) |
| BUDGETit | –6.195 |
|  | (15.078) |
| PUC\_TENUREit | –0.019 |
|  | (0.027) |
| ELECT\_PUCit | –7.347 |
|  | (20.476) |
| Observations | 762 |
| Chi-Square | 10130.10\*\*\* |
| Instruments | 58 |
| AR(1) | –1.390 |
| AR(2) | –0.056 |
| Hansen J Test | 26.561 |

Notes:

Standard errors in parentheses

\* *p* < 0.10, \*\* *p* < 0.05, \*\*\* *p* < 0.01

Table 5. GMM regression models of renewable energy purchases

|  |  |
| --- | --- |
|  | (6) |
| NEIGHBOR \_EFFECTit | –0.004 |
|  | (0.062) |
| PEER \_EFFECTit | 0.055 |
|  | (0.040) |
|  |  |
| PERCENT\_RENEWABLE\_PURCHASESit–1 | 0.284\*\*\* |
|  | (0.031) |
| HOME\_RPSit | 0.788\*\*\* |
|  | (0.163) |
| OPERATIONAL\_CAPABILITYit | 5.823\*\*\* |
|  | (0.390) |
| (HOME\_RPSit)\*(OPERATIONAL\_CAPABILITYit) | 0.094\*\*\*  (0.019) |
|  |
| RESIDENTIAL\_SALESit | 0.903 |
|  | (21.069) |
| INDUSTRIAL\_SALESit | 13.893 |
|  | (9.200) |
| MANUFACTURERSit | –45.353 |
|  | (68.612) |
| FIRM\_SIZEit | –0.062 |
|  | (0.085) |
| DEREGULATIONit | 1.830\*\* |
|  | (0.807) |
| VOLUNTARY\_REPORTINGit | –1.848 |
|  | (1.639) |
| INVOLUNTARY\_REPORTINGit | –0.803\*\* |
|  | (0.328) |
| CO2\_EMISSIONSit | 0.033 |
|  | (0.061) |
| SIERRA\_CLUBit | 0.181\*\*\* |
|  | (0.037) |
| NUCLEAR\_MORATORIUMit | 5.614 |
|  | (7.646) |
| DEMOCRATSit | 0.384 |
|  | (0.259) |
| BUDGETit | 9.201 |
|  | (14.438) |
| PUC\_TENUREit | –0.033 |
|  | (0.030) |
| ELECT\_PUCit | –25.187 |
|  | (42.266) |
| Observations | 762 |
| Chi Square | 5316.08\*\*\* |
| Instruments | 56 |
| AR(1) | –1.813 |
| AR(2) | –0.143 |
| Hansen J Test | 25.029 |

Notes:

Standard errors in parentheses

\* *p* < 0.10, \*\* *p* < 0.05, \*\*\* *p* < 0.01

1. RPS policies generally state a final objective date with a series of milestones at periodic intervals throughout the life of the policy. [↑](#footnote-ref-1)
2. A number of related studies have examined the development of the renewable energy sector in the United States. For example, Delmas *et al.* (2007) analyzed the potential for market deregulation as an opportunity for product differentiation into renewable energy generation. Several other studies have focused on the early growth of the independent power producer (IPP) sector in the 1980s (Russo, 2001, 2003; Sine, David, and Mitsuhashi, 2007; Sine and Lee, 2009), which now plays an important role as a source for renewable power bought and distributed by IOUs. [↑](#footnote-ref-2)
3. Entrepreneurial ventures in this sector occur at two levels. First, significant entrepreneurial activity has occurred at the IPP level, where project developers build merchant plants and sell power to IOUs by contract. Second, some deregulated states have seen, at the retail level, the entry of niche competitors who compete with IOUs for the distribution of electricity to final customers. [↑](#footnote-ref-3)
4. Sales to commercial customers, the remaining customer class, has been omitted to avoid a linear combination of these variables. [↑](#footnote-ref-4)
5. Many renewable energy–generating technologies involve multi-stage investments where a portion of the generation will come online each year for two or three years. For instance, utility-scale wind farms generally have two or three stages that are completed over a period of time. [↑](#footnote-ref-5)
6. Recall OPERATIONAL\_CAPABILITY takes the values –10 to –1. [↑](#footnote-ref-6)
7. The results of a Levin, Lin, and Chu panel unit root test indicate that we can reject the null hypothesis (*p* < 0.01) that the dependent variable is non-stationary and further supporting the expectation of a dynamic process. [↑](#footnote-ref-7)