THE EFFECT OF STATE RENEWABLE PORTFOLIO STANDARDS ON CONSUMER PARTICIPATION IN GREEN PRICING PROGRAMS

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Graduate School of Arts and Sciences
of Georgetown University
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degree of
Master of Public Policy
in Public Policy

By

James L. Maltese, A.B.

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James L. Maltese, A.B.

Thesis Advisor: Shaun Ledgerwood, Ph.D., J.D.

ABSTRACT

In the last several years, two mechanisms for increasing the supply of renewable electricity have become increasingly popular: renewable portfolio standards, a state policy of mandating increased production of green power; and green pricing programs, which allow customers to purchase green power through their utilities. These mechanisms have been effective in increasing the adoption of renewable energy; however, it is unclear whether they interact in a way that is mutually beneficial or counterproductive. It is important to understand the effect of renewable portfolio standards on the voluntary market for green energy, especially as Congress considers a nationwide portfolio standard. The effectiveness of a renewable portfolio standard may be undercut if it leads customers to purchase less green power.

This study analyzes the relationship between the passage and implementation of a renewable portfolio standard and two measures of enrollment in utility green pricing programs. Using eight years of data for all fifty states, the study utilizes multiple regression analysis with fixed-effects estimation. The results indicate that the passage of a renewable portfolio standard has a positive and statistically significant effect on green pricing enrollment within the state. At the same time, the rate at which states increase the stringency of the renewable portfolio standard is found to have no effect on enrollment. Although further study is needed to determine if additional factors are responsible for the observed increase in green pricing enrollment, this
study provides evidence that such programs do not harm, and may in fact encourage, voluntary purchases of green power.
ACKNOWLEDGEMENTS

I would like to thank Shaun Ledgerwood, my advisor, for all his guidance and encouragement throughout this process. I also thank Donna Morrison, Eric Gardner, and Mike Barker for their helpful comments and technical assistance. Finally, I thank my family for their love and support.
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Chapter 1. Introduction

Increased production of electricity from renewable energy sources, also known as “green power,” has clear benefits compared to the fossil fuel alternative: reduced air pollution, reduced greenhouse gas emissions, less dependence on foreign energy sources, and increased employment (so-called “green jobs”). Despite this, renewables make up only a small portion of the electricity generated in the United States: only 4 percent of US electricity in 2010 was generated from non-hydropower renewable sources,\(^1\) compared to 69 percent that came from coal or natural gas. (EIA 2011a). A major reason is that renewable energy is generally more costly to produce under current pricing regimes. In the marketplace, cheaper energy has trumped cleaner energy, in large part because the negative externalities of fossil energy are not fully incorporated into the price. The federal government has issued a patchwork of financial incentives for construction of new renewables, including tax credits and loan guarantees, but Congress has not passed a comprehensive policy to increase adoption of green power or improve its competitiveness.

In the absence of federal action, two notable developments have occurred to encourage expansion of renewable electricity. First, many state governments have developed renewable portfolio standards (RPS), which require utilities to ensure that a specified percentage of the electricity they generate comes from renewable sources. Second, utilities have responded to consumer demand for renewables by offering their customers the option of purchasing green power for their homes or businesses. Partly as a result of these mechanisms, renewable energy in the US has increased markedly over the last decade. From 2005 to 2009, the amount of electricity generated from renewable sources in the United States increased by 15.5 percent, and

\(^{1}\) Wind, solar, biomass, geothermal, and waste.
summertime capacity increased by 27 percent. (EIA 2011b). In the same period, wind power capacity and generation increased by a factor of four, and solar power increased by 50 percent.

The popularity of the RPS has led to repeated calls for the federal government to adopt a nationwide standard, particularly now that a cap-and-trade policy has been deemed politically infeasible as an approach to encouraging renewables and reducing greenhouse gas emissions. Whether an RPS has interaction effects with the voluntary green pricing market is an important consideration in determining whether to enact the policy.
Chapter 2. Policy and Related Literature

Renewable Portfolio Standards and voluntary Green Pricing Programs have shown significant growth in the last ten years. Many states have enacted RPS policies, and some states have strengthened their existing policies, while more and more utilities have created and expanded their green options. Multiple reviews have shown that the policies make meaningful contributions to the amount of installed renewable capacity. An open question is whether the two policies are complementary or competitive—do green pricing programs become more or less successful when a state passes an RPS?

Renewable Portfolio Standards

The first RPS policy was passed by Iowa in 1983, requiring utilities to produce 105 MW of green power. As of 2009, 23 states and the District of Columbia had implemented an RPS policy, and an additional 13 states had passed standards that had not yet gone into effect. (DSIRE 2011; UCS 2008).

Although RPS policies have many common elements, there is significant variation in their design from state to state. Unlike Iowa’s flat megawatt standard, most RPS policies set a floor on the percentage of the state’s electricity that must come from renewables. The percentage is usually scheduled to be raised over time to meet future goals. For example, California’s RPS requires that 20 percent of retail electric sales in 2010, and 33 percent in 2020, come from renewable sources, while Ohio has scheduled annual increases in its RPS up to an eventual 12.5

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2 The policy did not go into effect until 1997 due to litigation (UCS 2009). 105 MW is less than 1 percent of the electric generating capacity in Iowa; Iowa now has over 2,600 MW of wind power capacity. (EIA 2010a).
percent of sales by 2025. (DSIRE 2011). States also differ on such features as whether the RPS measures the percentage of electricity actually produced and delivered or the share of total electric capacity, whether hydropower counts as renewable energy, whether utilities can meet their commitment by purchasing renewable energy credits from other generators, and if so, whether those credits can be purchased from outside the state. (Petersik 2004).

States adopt RPS for a variety of reasons. The stated goals of the policies are usually to encourage the construction of new renewable generation (thus creating jobs within the state) and to decrease global warming and other types of air pollution. Lyon and Yin (2010) found that the significant determinants of whether a state adopts an RPS are the political ideology of the state legislature and the balance of energy interests in the state (solar and wind potential vs. natural gas generation). Whereas the solar and wind power industries are the prime beneficiaries of an RPS, it is believed that RPS is disproportionately harmful to the natural gas industry, because the additional renewable supply mandated by an RPS will first replace existing supplies of natural gas, which is more expensive than coal, despite being the cleaner-burning fuel.

RPS policies have proven popular in spite of the fact that they are likely not the most effective or efficient policies for increasing renewable generation or decreasing pollution. The policies are more costly and less efficient than a carbon tax or cap-and-trade program, and the decrease in greenhouse gas emissions that results will have only a small effect on the rate of climate change. Another possible effect of the policies is emissions leakage. This occurs when

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3 A high percentage target does not necessarily mean that the RPS goal is ambitious. For example, Maine’s initial goal of 30 percent renewables was lower than the existing percentage of renewables supply at the time of enactment. The goal was later amended to require an additional 10 percent of new renewable electric capacity.

4 Additionally, some states have different requirements depending on the type of utility. In these states, privately owned utilities face a different standard than municipally-owned utilities.
the amount of fossil fuel electricity generated in the state with the RPS decreases, but pollution does not decrease because the electricity generation is simply relocated to another state that has no RPS. Lyon and Yin (2010). In addition, there are concerns that states have generally not been in compliance with the targets they have set, and could face more difficulty meeting the targets in the future. Wiser, et al. (2010). For example, Bird, et al. (2010a) forecast that the east coast will face a renewable energy supply deficit by 2015.

Against this backdrop of debate over whether RPS policies are a smart way for states to encourage renewable production and limit pollution, several studies have examined whether the policies are effective at achieving those goals.

Wiser, et al. (2004a) demonstrated that the success of an RPS policy in positively impacting renewable energy development depends on its design. A review of the 13 RPS policies in existence at the time of the study revealed that many of them had spurred significant increases in the amount of renewable electricity produced. Wiser, et al. identified common design defects that hamper the effectiveness of various RPS policies. These include a narrow application to private utilities only, inadequate targets that are barely higher (or, in the case of Maine, lower) than existing renewables supply, lax enforcement and insufficient penalties for non-compliance, and a lack of clarity in the rules implementing the RPS that fails to provide certainty to investors in renewable energy projects.

Okazaki (2006) found that the existence of an RPS policy had a not-quite-significant effect (p=0.135) on the rate of increase in a state's renewable capacity. Okazaki looked at multiple state policies to support renewables and their effect on the change in capacity between 1993 and 2003. A significant effect was found for the duration of an RPS, as states with longer-
established policies experienced greater increases in renewable capacity. The study controlled for electricity price, income, state politics, and technical potential for renewable energy.

**Green Pricing**

An alternative policy for increasing adoption of renewable energy is to allow customers to directly purchase electricity generated from renewable sources. These green pricing programs are implemented by utilities and vary in their design. Generally, customers pay a premium on their electric bill to cover the greater cost of renewable energy. Customers might buy 100 kilowatt-hour blocks of wind or other renewable power for a set price, or pay a higher rate for a certain percentage of their electricity to come from renewable sources. Holt and Holt (2004).

Because electricity coming off the grid cannot be differentiated by its source, the notion of a customer controlling the source of his individual electricity supply is something of a fiction. In practice, the customer’s green pricing premium goes to subsidize renewable energy production.

The programs are largely voluntary for utilities to offer, though some states require utilities to offer a program. The programs are offered to both residential and commercial customers. The EPA has established a Green Power Partnership that encourages businesses to participate in purchasing green power.

The green pricing market has grown substantially in the past several years. In 2008, there were 643 electricity providers offering green pricing programs, up from 442 in 2005. (EIA 2010b) Over the same period, total sales of green power to residential customers grew from 3 million megawatt-hours to 5.5 million megawatt-hours, and the number of residential customers in regulated markets grew from 383,000 to 520,000. Sales to commercial customers more than tripled, to 18.8 million megawatt-hours (Bird et al. 2009; Bird et al. 2010b).
Unlike a mandatory RPS, green pricing allows market forces to shape the amount of renewables purchased. By choosing to pay extra for renewable energy, electricity customers can reveal their preferences and “willingness to pay” for renewables. However, the programs are susceptible to free rider problems, because nonparticipants share the environmental benefits of others’ participation (Wiser and Pickle 1997). This could explain why participation rates in the program (around 1 percent) are far below what would be expected from consumer surveys and other market research that reveal strong consumer interest in more renewable energy (Swezey and Bird 2001).

The success of green pricing programs can be evaluated across several dimensions, including the amount of green power purchased through the programs, the amount of new renewable generation capacity constructed as a result of these purchases, and the level of consumer participation achieved. This study follows other recent studies in examining participation. A primary factor in how many customers sign up for green pricing is how well the program is marketed (Bird and Kaiser 2007; Wiser and Pickle 1997). Swezey and Bird (2001) conclude that the best-performing green pricing programs prominently advertise, keep their premiums low, and make signing up easy. Marketing to potential customers can be expensive, however. Friedman and Miller (2009) found that the median utility spent 18.8 percent of the revenue from premiums on marketing in 2008, with some smaller utilities spending up to 49 percent.

A more rigorous statistical evaluation of green pricing programs was conducted by Wiser et al. (2004b). The study, which was based on a questionnaire filled out by 66 utilities offering green pricing, analyzed the determinants of the program participation rate and also the purchase rate—the percentage of the utility’s total electricity sales accounted for by the participants’
renewable purchases. A multivariate regression showed that, for residential customers, the size of the utility and the length that the program had been in effect were significantly correlated with higher participation and purchase rates (smaller utilities and older programs achieved better rates). In addition, the purchase rate was significantly affected by the contract length, frequency of marketing, and minimum purchase size. The authors considered adding an independent variable to control for whether the utility was subject to a state RPS. At the time, however, too few of the programs were subject to a mandate.

**Interaction of RPS and Green Pricing**

Most states that have an RPS in place also have utilities that offer green pricing programs. The overlap of these mechanisms presents special issues. There are two reasons to suspect that the passage of an RPS might negatively affect customer participation in green pricing.

A major question is whether green power purchases made through green pricing programs count towards the RPS mandate. If they do, then the voluntary purchases do not result in any more renewable electricity beyond what is required to meet the standard. Customers have little incentive to sign up and pay extra for green power that must be produced anyway. Many RPS states have rules to prevent this kind of double-counting, but other states are silent on the issue (Bird and Lokey 2007). Because the details of an RPS policy are not necessarily transparent to customers, whether an RPS negatively affects green pricing participation may depend on customers’ level of awareness of the overlap.

One of the reasons that green pricing has become popular is that electricity customers have desired to do their part to promote green energy in the absence of state or federal action. When a state passes an RPS, consumers may feel that their job is done, that the state has taken
responsibility for promoting renewable energy sources, and that the green pricing program has become superfluous.

Kneifel (2008) found that both RPS policies and state mandates for green pricing are effective at increasing renewable capacity in a state. Using a state fixed-effects model, Kneifel determined that a requirement that utilities offer a green pricing option would increase renewable capacity by approximately 1.4 percent, above and beyond the effects of other policies. He also determined that RPS policies mandating a specified amount of new renewable capacity (as opposed to requiring renewables to make up a certain percentage of electric generation) have been effective at achieving their goals. However, at the time of Kneifel’s study, only a handful of states had a green pricing mandate or an RPS with a capacity requirement.

Bird and Lokey (2007) examined the relationship between compliance markets (RPS) and voluntary markets (green pricing) for renewable energy. In response to concerns that introduction of an RPS would cause consumer interest in green pricing to flag, they pointed to increasing green power sales in several states following the passage of RPS. Without controlling for other explanatory factors, they found a statistically significant relationship between green pricing participation rates and existence of an RPS—states with an RPS had higher green pricing participation. Bird and Lokey acknowledged several factors that may explain the higher participation rates in RPS states, including: greater receptiveness to renewable energy in general by customers in RPS states, lower premiums for renewable energy in states with more renewable energy supply due to the RPS, and greater public awareness of renewable energy due to education about benefits of the RPS.

This paper builds on Bird and Lokey’s analysis of the interaction between RPS and green pricing. By controlling for additional factors not included in Bird and Lokey’s model, the goal is
to determine whether consumer demand for green power is affected by the existence of an RPS. The analysis incorporates Wiser et al.’s (2004b) suggestion of including RPS as an explanatory variable for the variation in the participation rate for green pricing programs.
Chapter 3. Data and Methodology

Research Design

To determine the effect of an RPS on green pricing enrollment, this study utilizes ordinary least squares (OLS) regression with fixed effects estimation. The study analyzes the question in two parts: first, among all states, does the passage and/or entry into force of an RPS affect enrollment in green pricing programs? Second, among states that have passed an RPS, does the strength of the targets affect green pricing enrollment?

The panel dataset consists of 408 observations—one for each state and the District of Columbia for each year between 2002 and 2009. At the start of this period, 10 states had passed an RPS, and at the end 36 had. There are 184 observations that reflect states with an RPS on the books.

Dependent and Independent Variables

The dependent variable is the percentage of residential electricity customers in each state who are enrolled in a green pricing program. Two different expressions of the enrollment rate are used in the four models. The statewide enrollment rate is calculated as the number of green pricing customers in the state divided by the total number of residential customers. The eligible enrollment rate limits the denominator to the number of customers whose utility offers a green pricing program. These customer tallies are self-reported by utilities to the Energy Information Administration (EIA), specifically in form EIA-861. The enrollment rate makes no distinction among the various designs of green pricing programs, and does not take into account the amount

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5 Some utilities report that all of their customers are enrolled in green pricing. Because these green utilities distort the results and do not accurately reflect consumer choice of a utility’s green pricing alternative, their customers have been removed from the numerator and denominator of the eligible enrollment rate.
of renewable electricity actually purchased. This study chooses to treat any consumer’s decision to enroll in a green pricing program equally, regardless of program design. This is consistent with the methodology used by Bird and Lokey (2007).

The decision to examine only residential, and not commercial, customers is due to the increased complexity of motivations that go into a commercial customer’s decision to purchase green energy. Whereas the economically rational residential consumer will balance the additional cost of green energy against his personal valuation of the public benefits of his energy purchase, a commercial customer will also consider factors such as the public relations effect, the reaction amongst shareholders, the actions of competitors, and the lobbying efforts of customers and entities like EPA’s Green Power Partnership. These complex motivations make it more difficult to successfully model a commercial entity’s behavior in choosing whether or not to enroll in a green pricing program.

Table 1 lists the independent variables used in the regression models below.

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6 One inaccuracy in the data has been adjusted for, however. From 2002 to 2005, the utility Green Mountain Energy reported nearly 400,000 green pricing customers in Ohio, though these customers were part of a community aggregation that purchased only 2 percent renewable energy (Bird 2009). Consequently, the observations for Ohio in these years have been excluded from the regression models reported below, due to the vastly inflated enrollment rate.
Table 1. Independent Variables

<table>
<thead>
<tr>
<th>Variable</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>RPS Passed</td>
<td>A flag indicating whether the state had passed a renewable portfolio standard in or before the current year.</td>
</tr>
<tr>
<td>RPS in Effect</td>
<td>A flag indicating whether the renewable portfolio standard had entered into force in or before the current year.</td>
</tr>
<tr>
<td>Green Pricing Eligible Share</td>
<td>The percentage of customers whose electric utility offered a green pricing option.</td>
</tr>
<tr>
<td>Average Residential Electricity Price</td>
<td>In cents per kilowatt-hour.</td>
</tr>
<tr>
<td>Average Individual Income</td>
<td>In thousands of dollars.</td>
</tr>
<tr>
<td>Median Age</td>
<td></td>
</tr>
<tr>
<td>Democratic Governor</td>
<td>A flag indicating whether the governor was a Democrat (=1) or Republican (=0).</td>
</tr>
<tr>
<td>Democratic Congressional Delegation</td>
<td>The percentage of the state's Congressmen that were Democrats.</td>
</tr>
<tr>
<td>Year</td>
<td>The year of observation, renumbered 1–8 for the years 2002–2009.</td>
</tr>
<tr>
<td>10-Year Goal</td>
<td>The renewable energy target that the RPS requires the state to meet ten years in the future.</td>
</tr>
</tbody>
</table>

Variables were selected based on their likely influence on a residential consumer’s decision to enroll in a green pricing program. The key variables of interest are indicators for whether the state had put in place an RPS, and the strength of the RPS targets. As a measure of the strength of the RPS, the study uses the target percentage of electricity that must come from renewable sources at a point ten years in the future. The study does not draw distinctions among RPS policies based on trading rules, the types of electricity counted as renewable, or other individual features, on the assumption that these features are not transparent to most residential consumers.\footnote{All but two states use percentages as their RPS goals. The remaining states, Iowa and Texas, have as their goals a specific number of megawatts of renewable electricity. Following the approach of Okazaki (2006), these megawatt targets have been converted to percentages by dividing the targets by the current electricity generation of each state (EIA 2011).}
electricity customers and therefore not relevant to modeling consumer choice. The strength of the RPS targets may likewise be a factor that has little visibility to the average consumer—if so, this should be reflected in the regression results.

Another factor influencing enrollment is access to a green pricing program; a customer cannot choose to enroll if no program is available. Because access is a necessary precondition for enrollment, it is expected that increased access will have a significant, positive effect on the enrollment rate. As a measure of access, this study uses the percentage of residential customers in the state who are eligible for green pricing. A customer is eligible if his utility has at least one green pricing customer in the state. This variable is not included in the models that use the eligible enrollment rate as the dependent variable, because those models are already limited to eligible customers only.

The decision to purchase green power may also be affected by a customer’s political attitudes, with more liberal states potentially likely to have more residents willing to pay a premium for green energy. As a proxy for these political attitudes, the study uses the party of the governor and the party balance in the state’s congressional delegation in the year of observation. Previous studies have used the percentage breakdown of the vote in presidential elections. Data on the party balance of each state’s legislature was not available in a uniform fashion.

Finally, the study includes two demographic measures. Average income of the state population is included to test whether income growth affects green pricing enrollment. Median age is included to determine the effect of an aging population on enrollment.

Several factors that are likely to have a strong influence on enrollment are not included in the study. These factors are characteristics of individual green-pricing programs, such as the price premium that participants pay, the aggressiveness and frequency of marketing messages.
informing customers of the program, and the length of time that the program has been operating. These factors were analyzed by Wiser, et al. (2004b). Because this study is conducted at the state level, rather than the program level or utility level, these variables could not be included. Chapter 5 provides additional discussion of these factors and suggestions for further study.

Data

State-level data were compiled from various sources for the years 2002 through 2009. Electricity price data and data on utilities offering green pricing come from the EIA. Income data come from the Bureau of Economic Analysis (BLS). Population and age data come from the Census Bureau. Information on RPS programs comes from the Database of State Incentives for Renewable & Efficiency (DSIRE), supplemented by the Renewable Electricity Standards Toolkit administered by the Union of Concerned Scientists.

Table 2 shows summary statistics for the data collected.

---

8 Price and income values have not been adjusted for inflation.
Table 2: Summary Statistics

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>Mean</th>
<th>Std. Dev.</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Dependent Variables</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Statewide Enrollment Rate</td>
<td>408</td>
<td>0.69%</td>
<td>1.12%</td>
<td>0%</td>
<td>7.61%</td>
</tr>
<tr>
<td>Eligible Enrollment Rate</td>
<td>333</td>
<td>3.59%</td>
<td>11.54%</td>
<td>0.002%</td>
<td>99.39%</td>
</tr>
<tr>
<td><strong>Independent Variables</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RPS Passed</td>
<td>408</td>
<td>0.451</td>
<td>0.498</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>RPS in Effect</td>
<td>408</td>
<td>0.265</td>
<td>0.442</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Green Pricing Eligible Share</td>
<td>408</td>
<td>38.18%</td>
<td>33.87%</td>
<td>0%</td>
<td>98.78%</td>
</tr>
<tr>
<td>Average Residential Electricity Price</td>
<td>408</td>
<td>9.990</td>
<td>3.340</td>
<td>5.65</td>
<td>32.50</td>
</tr>
<tr>
<td>Average Individual Income</td>
<td>408</td>
<td>$35,618</td>
<td>$6,812</td>
<td>$23,131</td>
<td>$68,381</td>
</tr>
<tr>
<td>Median Age</td>
<td>408</td>
<td>36.566</td>
<td>2.144</td>
<td>27.459</td>
<td>42.237</td>
</tr>
<tr>
<td>Dem Governor</td>
<td>408</td>
<td>0.495</td>
<td>0.501</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>% Dem Congressional Delegation</td>
<td>408</td>
<td>0.494</td>
<td>0.310</td>
<td>0</td>
<td>1</td>
</tr>
</tbody>
</table>

**IF RPS Passed = 1**

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>Mean</th>
<th>Std. Dev.</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>RPS Years in Effect</td>
<td>184</td>
<td>0.484</td>
<td>4.182</td>
<td>-17</td>
<td>12</td>
</tr>
<tr>
<td>Mandatory</td>
<td>184</td>
<td>0.897</td>
<td>0.305</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>10-Year Goal</td>
<td>184</td>
<td>12.74%</td>
<td>7.69%</td>
<td>0</td>
<td>40%</td>
</tr>
</tbody>
</table>

There is significant variation in the statewide enrollment rate. Although most states (76 percent of observations) have an enrollment rate of less than one percent, a small number of states have much larger rates. Notably, Oregon’s 7.6 percent enrollment in 2009 is more than twice that of the next highest-ranking state. See Figure 1.
The enrollment rate shows even larger variation when limited to customers who have the option of choosing green pricing. See Figure 2. Though half of all observations have enrollment rates less than one percent, a handful of states see participation above 20 percent. These extremely large rates are due to a small number of utilities that focus a large part of their business on green power. The long right tail of the distribution suggests a potential difficulty with using OLS estimation: the small number of outliers could exert significant influence on the coefficient estimates, pulling them upwards to explain the large values and reducing their usefulness for explaining the small variations in the bulk of observations.
The RPS variables reflect the growing popularity of the policy. During the period 2002–2009, 26 states passed an RPS policy, and 18 states saw the requirements of their RPS enter into force.

Statistical Tests

As a preliminary test of the effect of an RPS on the enrollment rate, Table 3 shows the result of t-tests for the difference in the mean statewide enrollment rate for states with or without an RPS, for each year of data. The results show a widening gap in enrollment over time, with RPS states having higher enrollment than non-RPS states. Only in the last three years is the difference statistically significant, with RPS states having an enrollment rate about 0.7 percentage points higher, on average.

Table 3. Difference in Mean Statewide Enrollment Rate in States with or without an RPS

<table>
<thead>
<tr>
<th></th>
<th>Mean (No RPS)</th>
<th>Mean (RPS passed)</th>
<th>Difference</th>
<th>t</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pooled</td>
<td>0.419</td>
<td>0.883</td>
<td>0.465</td>
<td>5.03***</td>
</tr>
<tr>
<td>2002</td>
<td>0.290</td>
<td>0.245</td>
<td>-0.045</td>
<td>0.25</td>
</tr>
<tr>
<td>2003</td>
<td>0.406</td>
<td>0.400</td>
<td>-0.006</td>
<td>0.03</td>
</tr>
<tr>
<td>2004</td>
<td>0.456</td>
<td>0.592</td>
<td>0.136</td>
<td>0.65</td>
</tr>
<tr>
<td>2005</td>
<td>0.490</td>
<td>0.728</td>
<td>0.237</td>
<td>1.02</td>
</tr>
<tr>
<td>2006</td>
<td>0.506</td>
<td>0.872</td>
<td>0.366</td>
<td>1.43</td>
</tr>
<tr>
<td>2007</td>
<td>0.468</td>
<td>1.126</td>
<td>0.657</td>
<td>2.08**</td>
</tr>
<tr>
<td>2008</td>
<td>0.367</td>
<td>1.067</td>
<td>0.700</td>
<td>2.07**</td>
</tr>
<tr>
<td>2009</td>
<td>0.406</td>
<td>1.102</td>
<td>0.696</td>
<td>1.81*</td>
</tr>
</tbody>
</table>

* p<0.10    ** p<0.05    *** p<0.01

The t-tests do not tell us whether the enrollment rate increases in a state following passage of an RPS, nor do they provide controls for the other factors that may influence both enrollment and the RPS. One possible explanation for the correlation is that states with a more liberal population...
are likely to have higher enrollment, and such states are also more likely to elect politicians who will pass an RPS. The statistical tests that follow will test this hypothesis.

**Regression Models**

The regression models used in this study control for the fixed effects of each state—those that do not change over time. By controlling for fixed effects, the model can better evaluate the existence of a causal relationship between RPS and green pricing enrollment, rather than a mere correlation. Any inherent characteristics of individual states that influence the green pricing enrollment rate are eliminated, and there is no risk of omitted variable bias from excluding these unknown factors. Additionally, these controls are a safeguard against the autocorrelation that would result from performing simple OLS on the pooled panel dataset. The drawback of a fixed effects model is that it can only measure the effect of those factors that change over the time period. Consequently, for any states where the value of an independent variable remains constant over the period (for example, if the state had an RPS the entire time, or if the governor was always of a specific political affiliation), that piece of data will add little to the statistical power of the model. Further, the model only looks at variations within each state and not across states.

The four regression models examined below differ across two dimensions: the choice of dependent variable and the set of states examined. Table 4 summarizes the differences in the models.
The difference in the dependent variables is described earlier in this chapter. As mentioned previously, Models 1 and 3, which utilize the statewide enrollment rate, include an additional independent variable to measure the effect of greater access to a green pricing program. As to the difference in the samples, Models 1 and 2 examine all states, including states that had not passed an RPS, to examine the effect of passage. Models 3 and 4 restrict the sample to those observations of states in years where an RPS had been passed. These models add an additional variable to measure the strength of the RPS target.

All of the models assume a linear relationship between a single-unit change in the independent variables and a corresponding change in the green pricing enrollment rate. With respect to the variable measuring the strength of the RPS target, the assumption of linearity may be flawed. For this assumption to hold true, and for the results to be unbiased, the effect of an increase in the target must be the same across all levels of the target within a specific state (i.e., the rate of change must be constant). It may, however, be the case that an increase in the target from, for example, 7 to 9 percent (which occurred in Arizona between 2007 and 2009) may not have the same magnitude effect as an increase from 18 to 20 percent (observed in Delaware between 2008 and 2009). This caveat also applies to other continuous variables in the models, particularly average income and average electricity price.
Chapter 4. Results and Discussion

The multiple regression models in this study are presented below in two stages. The first set of results examines the two measures of the green pricing enrollment rate across all states, with and without an RPS policy. The second set restricts the sample to states with an RPS.

Models 1 and 2

Table 5 provides the results for Models 1 and 2. Model 1 regresses the statewide enrollment rate for all residential electricity customers in the state. Model 2 regresses the enrollment rate for residential customers in a utility that offers green pricing.

Table 5: Regression Results—All States, All Years

<table>
<thead>
<tr>
<th>Variable</th>
<th>Model 1: Statewide Enrollment Rate</th>
<th>Model 2: Eligible Enrollment Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>-6.038 (3.958)</td>
<td>-100.663 (91.437)</td>
</tr>
<tr>
<td>RPS passed</td>
<td>0.184 (0.087) **</td>
<td>4.964 (1.795) ***</td>
</tr>
<tr>
<td>RPS in effect</td>
<td>0.118 (0.097)</td>
<td>-5.222 (2.043) **</td>
</tr>
<tr>
<td>Green pricing eligible share</td>
<td>0.005 (0.001) ***</td>
<td>---</td>
</tr>
<tr>
<td>Avg residential electricity price</td>
<td>-0.014 (0.025)</td>
<td>-1.546 (0.684) **</td>
</tr>
<tr>
<td>Avg income (thousands)</td>
<td>-0.030 (0.018) *</td>
<td>1.035 (0.390) ***</td>
</tr>
<tr>
<td>Median age</td>
<td>0.204 (0.105) *</td>
<td>2.407 (2.414)</td>
</tr>
<tr>
<td>Dem governor</td>
<td>0.004 (0.072)</td>
<td>-3.255 (1.654) *</td>
</tr>
<tr>
<td>Dem congressional delegation</td>
<td>-0.323 (0.197)</td>
<td>-2.264 (4.780)</td>
</tr>
<tr>
<td>Year</td>
<td>0.078 (0.034) **</td>
<td>-0.964 (0.769)</td>
</tr>
<tr>
<td>Number of observations</td>
<td>404</td>
<td>333</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.287</td>
<td>0.103</td>
</tr>
</tbody>
</table>

* p<0.10     ** p<0.05     *** p<0.01
Model 1 finds that the passage of an RPS has a positive effect on green pricing participation, significant at the 95 percent confidence level. Specifically, the model predicts that a state that passes an RPS will see the statewide enrollment rate increase by 0.18 percentage points. This is an increase of 29 percent relative to the mean enrollment rate. Model 2 also finds a positive effect for passage of an RPS, significant at the 99 percent level. The RPS increases enrollment by nearly 5 percentage points among the eligible customer base, which is a 140 percent increase over the mean eligible enrollment rate.

The increase in the eligible enrollment rate from an RPS is wiped out, however, when the RPS requirements enter into effect. Model 2 shows that the effect of an RPS coming into force is significant, opposite in sign, and slightly greater in magnitude than the effect of the RPS being passed. It is unclear why enrollment should decrease after the RPS takes effect. One explanation is that utilities lessen their marketing efforts, particularly if green pricing sales cannot count toward the RPS requirements. Another possibility is that utilities begin to offer green pricing programs or expand their current offerings when the RPS goes into effect, which increases the denominator of the eligible enrollment rate in the short term. Alternatively, the negative effect might reflect customers who do not remain enrolled in green pricing programs over the long term. As more renewables are installed in the state to meet the mandate, customers may decide they no longer want to pay extra for the widely-shared resource.

Model 1, by contrast, suggests that an RPS going into effect has no significant impact on the statewide enrollment rate. The two results are not necessarily incompatible; if utilities respond to the RPS going into effect by expanding green pricing programs, this would have the effect of increasing the pool of eligible customers and decreasing the eligible enrollment rate, while still increasing the statewide enrollment rate, or leaving it unchanged. An anecdotal
example is Pennsylvania. From 2005 to 2006, when Pennsylvania’s RPS went into effect, the population eligible for green pricing shot up by a factor of 40. The number of green pricing customers in the state more than doubled, as did the statewide enrollment rate, but the eligible enrollment rate shrank from 26.5 percent to 5 percent.

As expected, the share of customers who are eligible for a green pricing program has a highly significant effect on statewide enrollment. Model 1 estimates that expanding green pricing to an additional ten percent of residential customers would increase overall enrollment by 0.05 percentage points. The coefficient on the eligible share is essentially a conversion rate; the model predicts that 0.5 percent of the expanded eligible population will enroll. This is less than the mean enrollment rate, and indicates diminishing returns to enrollment as green pricing becomes available to a larger segment of the population.

Model 2 finds that enrollment decreases as the price of electricity goes up. This is consistent with the economic principle of an income effect; customers are less eager to spend more for electricity when their bills are already high, even though the green pricing premium is proportionately smaller as the general price of electricity goes up. The effect is large, as the model predicts that for every cent-per-kilowatt-hour that the price of electricity increases, the eligible enrollment rate declines by 1.5 percentage points. The effect of electricity price is not significant in Model 1.

The effect of average income growth on enrollment is negative in Model 1, but positive in Model 2. Each effect is significant, though to a much greater degree in Model 2. In Model 1, an additional $5,000 in average income reduces statewide enrollment by 0.15 percentage points. Model 2 predicts that the same $5,000 increase results in a 5.16 percentage point increase in the eligible enrollment rate. A positive relationship between income growth and enrollment is more
plausible. One would expect individuals as they become wealthier to be better able and more willing to pay the premium for green power.

The lack of significance of the political economy variables is somewhat surprising. Neither model finds a significant effect from the state’s party balance in Congress, and Model 1 finds that the party of the governor has no effect. This is probably due to the nature of the fixed effects estimation, because these variables are proxies for the political attitudes of the population, which are largely fixed over time. Consequently, once the fixed effects are removed the political variables have little left to explain. Also, there is relatively little variation within each state over the period of the dataset. For example, 20 states had a governor of the same party for each year from 2002 to 2009, and another 16 had a governor of one party for 7 of the 8 years. There may also be an issue of time lag, since the change in political attitudes that is reflected in affinity for green pricing may not coincide temporally with the election of new politicians. Model 2 does find that a change in the party of the governor has a significant effect, with the enrollment rate increasing by 3.25 percentage points when a Republican governor replaces a Democrat.

Finally, Model 1 finds that the median age of the state has a significant effect on enrollment, with enrollment increasing by 0.2 percentage points for every year that the population ages. This effect is actually quite small. The year-over-year change in median age for any given state is closer to ±0.2, which corresponds to an increase in the enrollment rate of 0.04 percentage points. An increase in the median age implies that younger residents are leaving the state, or having fewer children. If enrollment increases as younger residents leave, this result suggests that older customers are more likely to purchase green energy than younger ones. Model 2 finds no significant effect from a change in the median age.
Although the results of Model 2 are more in line with expectations, Model 1 does a better job of explaining the variation in the dependent variable. Model 1 has an r-squared value of 0.287, compared to 0.103 for Model 2. This is probably due to the strong correlation between the eligibility percentage and the statewide enrollment rate.

Models 3 and 4

The results presented in Table 6 are restricted to states that had passed an RPS in or before the year of observation. Model 3 regresses the statewide enrollment rate, and Model 4 regresses enrollment among customers who were eligible for a green pricing option.

Table 6: Regression Results—RPS Restricted

<table>
<thead>
<tr>
<th>Variable</th>
<th>Model 3: Statewide Enrollment Rate</th>
<th>Model 4: Eligible Enrollment Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>-3.163 (5.859)</td>
<td>-145.434 (175.804)</td>
</tr>
<tr>
<td>RPS in effect</td>
<td>0.144 (0.100)</td>
<td>-5.645 (2.983) *</td>
</tr>
<tr>
<td>Green pricing eligible share</td>
<td>0.012 (0.002) ***</td>
<td>---</td>
</tr>
<tr>
<td>Avg residential electricity price</td>
<td>0.012 (0.030)</td>
<td>-3.850 (1.278) ***</td>
</tr>
<tr>
<td>Avg income (thousands)</td>
<td>-0.066 (0.025) ***</td>
<td>-0.201 (0.753)</td>
</tr>
<tr>
<td>Median age</td>
<td>0.144 (0.157)</td>
<td>5.629 (4.701)</td>
</tr>
<tr>
<td>Dem governor</td>
<td>0.022 (0.119)</td>
<td>-3.398 (3.471)</td>
</tr>
<tr>
<td>% Dem congressional delegation</td>
<td>-0.056 (0.333)</td>
<td>-14.393 (10.381)</td>
</tr>
<tr>
<td>Goal +10</td>
<td>0.005 (0.012)</td>
<td>-0.002 (0.347)</td>
</tr>
<tr>
<td>Year</td>
<td>0.120 (0.049) **</td>
<td>1.953 (1.520)</td>
</tr>
<tr>
<td>Number of observations</td>
<td>184</td>
<td>161</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.403</td>
<td>0.164</td>
</tr>
</tbody>
</table>

* p<0.10     ** p<0.05     *** p<0.01
The main purpose of limiting these two models to states with an RPS is to allow for the use of the RPS target goal as an independent variable. Both Models 3 and 4 indicate that the strength of the RPS goal has no significant effect on the enrollment rate. Chapter 4 discussed the possibility of an incorrect specification for the RPS strength variable. However, it is unlikely that a non-linear specification would detect a relationship given the severe lack of significance in Model 3 (p=0.68) and Model 4 (p=0.996). RPS policies vary widely in the aggressiveness of their requirements from state to state. From the perspective of residential electricity customers, however, the speed with which states increase the burden on utilities to utilize renewable energy appears to make no difference in customers’ decisions to purchase such energy for themselves.

The remaining results closely track the results from Models 1 and 2. Model 3 concurs with Model 1 in finding no significant effect from the RPS going into force, but a highly significant effect for an increase in green pricing eligibility. The magnitude of the effect is more than twice that identified in Model 1, and indicates that, in states that have passed an RPS, expanding the eligible population by ten percentage points increases the statewide enrollment rate by 0.12 percentage points. In other words, 1.2 percent of newly eligible customers are predicted to enroll, which is greater than the mean eligible enrollment rate of 0.88 percent in RPS states.

Like Model 1, Model 3 finds that an increase in average income has a negative effect on statewide enrollment, though in Model 3 the effect is more significant, statistically and substantively. According to the results, an increase of $5,000 in the average income of an RPS state results in a decrease of 0.33 percentage points in the enrollment rate.

Both of the restricted models have higher r-squared values than their unrestricted counterparts, despite finding fewer of the independent variables to be significant. This could be
because the RPS states have more in common, and so there is less variation for the independent variables to explain.
Chapter 5. Policy Implications and Conclusions

The potential effect of RPS on voluntary green power purchases is particularly salient as Congress considers passing a nationwide RPS (or, as it has recently been referred to, a Clean Energy Standard). The simple assumption is that such a policy will increase the total amount of green power by whatever amount is necessary to meet the targets. However, a full debate on the merits of an RPS must consider the ancillary consequences of the policy. If passing an RPS reduces consumer demand for green pricing, the policy will fall short of its stated goal. If, on the other hand, the RPS spurs voluntary purchases, then the policy will exceed the goal and deliver a “green pricing bonus.”

This study presents two models of green pricing enrollment that indicate a positive relationship between the adoption of an RPS policy and enrollment. The results suggest that passing an RPS encourages residential customers to voluntarily purchase green power. For example, in Tennessee, which has 19,800 residential green pricing customers as of 2009 but no RPS, Model 1 predicts that, all else being equal, passing an RPS would increase the statewide green pricing participation rate from 0.74 percent to 0.91 percent, netting 4,600 additional green power purchasers. Model 2 predicts an increase in the eligible enrollment rate from 0.78 percent to 5.74 percent, which would increase enrollment by 125,000 customers, assuming the eligible population remains the same (though after the RPS goes into effect, the Model predicts a net decrease of 6,700 customers). Either of these divergent results would be a significant boost for renewable energy production, above and beyond the requirements of the RPS.

Although the precise mechanism for the effect of an RPS on green pricing enrollment is unclear, one plausible explanation is that the passage of the RPS establishes renewable energy as a policy priority for the state, effectively sending the message to residents that “In this state, we
The results provide little evidence for the concern expressed by Bird and Lokey (2007) that customers will be disincentivized to purchase green energy once an RPS has been passed because such purchases might go toward fulfilling the RPS mandate that utilities would have to meet anyway. On the contrary, passing an RPS might actually mitigate the existing free-rider problem; customers may feel better about making voluntary purchases of green power in the belief that the RPS spreads the cost of green power to all customers, even though they are still paying more than non-participants.

Two of the models suggest that passing and implementing an RPS leads to an overall decline in the enrollment rate among those whose utility offers a green pricing program. This could mean that customers drop out of the green pricing programs, or it could mean that green pricing programs become more widely available when an RPS is implemented. One suggestion for further study is to determine whether an RPS has a significant impact on the size of the green-pricing-eligible population.

Further, the lack of any significant effect on enrollment from the size of the RPS targets suggests that the selection of the targets is irrelevant to the green pricing bonus effect. The lesson for policymakers is that the size of the targets should be set based on other considerations than green pricing, such as the environmental benefit to be achieved or the cost of compliance. If the legislature takes care of the RPS, the green pricing will take care of itself. This is not to say that lawmakers have no control over green pricing enrollment. As Kneifel (2008) discovered, a state requirement that all utilities provide a green pricing option has a substantial effect on the amount
of renewable energy capacity. This study observes that the green pricing enrollment rate increases when more of the population has access to a green pricing program (see Models 1 and 3). Six states currently have such a requirement; most were passed as part of the same legislation that created the RPS in those states. Other states should add a similar mandate as part of their RPS.

One of the main limitations of the models used in this study has been the lack of information about the green pricing programs themselves. Some of the results reported in Chapter 4 might also be explained not by consumer behavior, but by changes in how the utilities manage their programs. For example, Models 2 and 4 find that an RPS has a negative effect on participation when the targets become binding. As discussed above, it is possible that utilities shift their focus away from green pricing and towards using their renewable resources to meet the RPS targets. As to the primary finding of this study, that the passage of an RPS increases green pricing enrollment, an alternative explanation could be that utilities improve the marketing of their green pricing programs following the passage of an RPS, or launch green programs if they had none before. The utilities’ goal would be to capitalize on the publicity surrounding renewable energy, and to defray the cost of the new renewable capacity required to comply with the RPS targets.

To complement the findings presented here, a further study should return to the utility-level model used by Wiser, et al. (2004b) to examine the interaction of RPS with factors such as the green pricing premium, frequency of marketing messages, and the size and duration of the program. A model that includes these factors may be able to explain much more of the variation in the enrollment rate than the models reported in this study.
Additional study should also be given not only to participation in green pricing programs, but to the amount of energy purchased through green pricing sales. It is possible that the passage of an RPS affects how enrolled customers purchase their energy through green pricing programs, even if they do not drop in or out of the programs.

Although further study is needed, the results of this analysis provide additional support for the effectiveness of an RPS policy. The policy pays additional dividends for renewable energy by leading customers to make complementary green power purchases of their own.
References


