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Research note

Renewable energy potential and adoption of renewable portfolio standards

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ABSTRACT

Thirty states have adopted renewable portfolio standards (RPSs) that set targets for renewable energy generation by mandating electric power utilities obtain a minimum percentage of their retail load from renewable sources. To date, a number of studies have consistently found that political and economic factors impact RPS adoption. Studies have also examined the impact of renewable energy potential in a state on the probability of RPS adoption, but results have largely been statistically weak and inconclusive. After controlling for political and economic factors, we estimate that a one standard deviation increase in wind potential is associated with an approximately 4.2 percentage point increase in the probability of having an RPS, and a one standard deviation increase in solar potential is associated with a 6.1 percentage point increase in the probability of having an RPS.

1. Introduction

This paper analyzes factors that predict renewable portfolio standard (RPS) adoption. In addition to considering political and economic factors that have been consistently shown to be strong predictors, we focus on another factor that has received less attention, namely "renewable energy potential" or "renewable energy resource endowment," hereafter simply referred to as "renewable potential." Consistent with previous findings, we find that political and economic factors impact RPS adoption, but in addition we find evidence that renewable potential is also a strong predictor.

Renewable portfolio standards are state-level policies in the U.S. that legislatively mandate that a portion of a state's electrical retail load be produced by renewable sources by a specified future date. RPS policies target utilities and other electricity providers and require that they comply with the regulatory mandate. RPS policies commonly include a system of renewable energy credits (RECs), in which renewable energy producers generate one REC for every MWh of renewable electricity produced. RECs can be bought and sold to help electricity providers meet their RPS obligations. States might implement RPS standards for a number of reasons; they may want to diversify their electricity portfolio, encourage investment in the renewable energy sector, improve state air quality, or reduce CO_2 emissions to combat climate change (Lyon and Yin, 2010).

It has consistently been shown that political and economic factors can impact a state's decision to implement an RPS (Fowler and Breen, 2013; Chandler, 2009; Huang et al., 2007; Lyon and Yin, 2010). In addition, some studies have tested whether states with significant renewable potential have been more likely to adopt RPS policies (Matisoff, 2008; Chandler, 2009; Lyon and Yin, 2010; Yi and Feiock, 2012). States with high renewable energy resource endowments are hypothesized to be more likely to implement an RPS. The first obvious reason for RPS adoption is that states with relatively high renewable potential may expect that compliance with an RPS policy will be relatively inexpensive for utilities and ratepayers as a fixed investment will produce relatively more electricity. On the other hand it might be cost prohibitive, and potentially not feasible, for states with relatively little wind and/or solar potential to meet an RPS requirement without purchasing a large number of RECs from interstate markets. In addition, states may implement an RPS in an attempt to stimulate in-state economic activity. States with relatively large resource endowments might expect that a larger proportion of the economic benefits associated with renewable projects' construction and operation may occur within state bounds, and therefore be more likely to

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implement RPS policies. Conversely, states without a large natural resource potential may have concerns that an RPS will result in a subsidy from in-state ratepayers for renewable projects across state lines.

To our knowledge, Huang et al. (2007) were the first to analyze factors that impact the probability of RPS adoption, finding that adoption is nonrandom and is influenced by political factors, education levels, gross state product (GSP), and the population growth rate. They observed that states with relatively high GSP per capita and more Democratic state legislators were more likely to have adopted an RPS than states with relatively low GSP and more Republican state legislators.

Matisoff (2008) also found that GSP per capita and liberal citizen ideologies were positively related to the probability of RPS adoption and in addition examined the effects of renewable energy resource endowments on the adoption of climate change policies. Results were largely inconclusive, providing no evidence of the impact of natural resource endowments in one specification and weakly significant evidence of solar potential (but not wind potential) on RPS adoption in another. In part, Matisoff's failure to find conclusive results may be due to two factors. First, the paper utilized data on wind resource endowments that is based on a 30-m hub height compared to an 80-m hub height that was more standard over the time period in which RPSs were being adopted. This database was constructed in 1993, while the bulk of the RPSs were adopted a decade later. Second, Matisoff relied on relatively small sample sizes with only cross-sectional variation across forty-eight states in one specification and limited variation across time in another. Using similar empirical techniques, Chandler (2009) again found that political and economic factors impact RPS adoption but found no effect of renewable potential.[1]

Lyon and Yin (2010) utilized a logistic regression model and again found that political and economic variables are associated with the adoption of RPS policies. This is also the first paper to find a statistically significant effect of both wind and solar potential on RPS adoption. This finding is in contrast to the results of Chandler (2009) (who found no effect) and Matisoff (2008) (who found mixed and weak effects).

Most recently, Yi and Feiock (2012) included a rough proxy of renewable energy generation potential, namely the number of sunny days and the state average wind speed, in a model of RPS adoption. They found inconsistent and statistically weak evidence of the effect of these rough proxies of renewable potential on RPS adoption.

Thus, there is no consensus as to the effect of renewable resource endowments on the adoption of RPSs. Potentially due to lack of previous evidence, several of the most recent studies examining RPS adoption have failed to include natural resource variables in any specification (Carley and Miller, 2012; Fowler and Breen, 2013; Coley and Hess, 2012). The failure to find consistent results, and the exclusion of these variables in recent studies, may indicate that wind and solar potential simply do not guide policy decisions about RPS adoption. But this may also stem from methodological issues, especially the use of poor or antiquated indicators of renewable energy generating potential, and relatively small sample sizes might also play a role in poor statistical strength. We improve upon these previous studies by using recent data specifically developed to quantify renewable generating potential for both solar and wind. In addition, we utilize a panel of forty-nine states over more than two decades with time-variant political and economic variables as well as time-invariant wind and solar potential to estimate the marginal effect of each of these factors on RPS adoption.

Whether or not renewable potential impacts RPS adoption is of relevance to policymakers who are interested in understanding the impact of RPSs on outcomes of interest, such as renewable energy generation and emissions. For example, simply observing differences in the change in levels of renewable generation in RPS states and non-RPS states will not provide an unbiased estimate of the effectiveness of RPSs in spurring renewable generation *if* states with high renewable potential are also more likely to implement an RPS *and* are more likely to invest in renewable resources regardless of whether an RPS is in place. An observed increase in renewable energy generation might be falsely attributed to the RPS. Therefore, understanding the range of relevant factors that impact potential policy outcomes is critical.

2. Methods

2.1. Data

We utilize the U.S. Department of Energy's National Renewable Energy Laboratory's (NREL) estimate of wind and solar resource potential by state (NREL, 2010a). The solar resource is defined as the average irradiance received per day by the average m^2 of area in the state. The irradiance is then averaged over the year to give irradiance in $kWh/m^2/day$. Direct normal irradiance (DNI) is a measure of the irradiance received by a unit of area that is always normal (perpendicular) to the sun's rays. DNI is used by NREL because it is the industry standard used to assess solar resources available at potential sites for utility scale projects.

NREL (2010b) provides estimates of the maximum wind energy potential by state. NREL defines “windy” areas as those with wind speeds above 6.5 m/s at an 80-m hub height, again consistent with benchmarks commonly used in considering construction sites of utility-scale systems.[2] NREL then subtracts land area that is unsuitable for wind development to generate an estimate of the potential electricity generation if all of the commercially viable (windy) land area in a state were to be used to generate electricity after excluding incompatible land use. Together, these are the most thorough measures of wind and solar potential utilized in any study to date.

We also include the political and economic variables that have consistently been shown to impact RPS adoption in our model. Data on the number of Democrats and Republicans in each chamber of each state's legislature and the party of the governor are used to measure the political climate or leanings of each state at a given time (Klarner et al., 2012).

Data on the total gross state product and the mining and manufacturing gross state products were collected from the U.S. Bureau of Economic Analysis (BEA, 2014). The population of each state in each year is used to normalize these economic variables on a per-capita basis. Yearly state level population estimates come from the U.S. Centers for Disease Control's (CDC) National Center for Health Statistics (CDC, 2014). Basic summary statistics are presented in Table 2.

2.2. Empirical model

Equation (1) shows the empirical specification used to test

[1] Chandler's renewable potential variable differed from Matisoff (2008) in that it included biomass in addition to wind and solar.

[2] As of 2015, hub heights above 80-m are common, but 80-m was a standard hub height for utility scale systems over much of the period of this analysis.