Assessing the Effectiveness of Renewable Portfolio Standards: An Analysis of Electricity Prices, Renewable Energy Generation and Emissions Reductions

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Overview

Thirty states have adopted renewable portfolio standards (RPS) that set targets for renewable energy generation by mandating electric power utilities to obtain a minimum percentage of their power from renewable sources. To date, there have been a number of studies that examine the effectiveness of RPSs on achieving these outcomes. Overall, these studies find that RPSs are associated with increase in renewable power generation and decreases in emissions, but none of the studies take into account non-random adoption of these programs. Furthermore, none of these studies empirically consider potential mechanism through which these policies are effective. This is the first study to empirically estimate the impact of an RPS on state level electricity prices, renewable electricity generation and emissions while considering the non-random adoption of these policies. Using a number of empirical specifications including synthetic controls methods pioneered by Abadie et al., 2010, we find little evidence that states who adopt RPS have significant increases in renewable generation. We do, though, find evidence that RPS lead to increases in electricity prices and decreases in overall emissions compared to states that have very similar renewable generation potential, political environments and manufacturing and mining economic activity.

Methods

We employ three different empirical techniques to estimate the effect of state level RPS policies on electricity prices, renewable generation, and emissions incuding difference-in-differences (DD), instrumental variables (IV) and scenthetic controls (SC). First, we emoploy DD along with a number of covariates including state level political and economic characteristics. The 19 "untreated" states are used as the control group in this analysis.

The main identifying assumption needed for an unbiased estimate of the treatment effect in the DD estimation is that the treatment of the RPS is uncorrelated with unobserved shocks to electricity prices, renewable generation and emissions. It is very unlikely that this identifying assumption is valid as the treatment of these RPSs is not random and there are known factors that can predict RPS adoption. (Fowler and Breen, 2013; Chandler, 2009; Ming-Yuan et al., 2007; Lyon and Yin, 2010) For instance, if states that have higher renewable energy generation potential are more likely to implement an RPS and states with high renewable energy generation potential also build more renewable energy capacity regardless of whether an RPS is implemented, then the estimated treatment effect will pick up this increase in renewable generation associated with renewable energy potential and falsely associate this to the RPS. For this reason two additional empirical techniques are employed.

The first way that we will address this issue is by implementing a two state least squares estimator that will predict RPS adoption in the first stage. The literature on predicting adoption of RPS has primarily focused on political and economic factors. In addition to political and economic factors, we offer a novel predictor of RPS implementation--the renewable energy generation potential for both solar and wind within the state. (Archer and Jacobson, 2003, 2005; Lu et al., 2009) These variables do not tell us the actual amount of renewable generation nor the renewable generation capacity, but instead provide a metric for the maximum amount of renewable energy generation *potential* in the state, if the state were to essentially maximize the total solar and wind production based on physical constraints and geographic characteristics.

There have been substantial critiques to empirical literature that employs DD estimation (Bertrand et al., 2004, Abadie et al., 2010). Due to critiques primarily about non-robustness to placebo tests especially when the number of treated units is relatively small, researchers have been pushed to conduct additional robustness checks to assure that results from DD estimation are indeed valid. Using a vector of pre-treatment characteristics made up of the covariates used in the DD and IV estimates, a "synthetic state" is made to correspond ot each treated state as well as each non-treated state for the purpose of a placebo test.

Results

The implementation of RPS had a significant and positive impact on electricity prices and this result was consistent across analytic methods. More specifically, we estimate that RPS adoption is associated with approximately a 1¢/kwh increase in electricity prices. Conversely, each of the empirical techniques imployed finds no statistically significant effect of RPS policies on renewable energy generation. Despite the fact that there was no impact on renewable generation capacity, we estimated that CO_2 emissions decreases by approximately .35 tons per person.

Conclusions

The observation that RPS policies decrease emissions but do not have an impact on renewable energy generation may seem unexpected. Potentially, the channel through which this ocurrs is Renewable energy certificates (RECs). RECs are tradable credits that are a commonplace policy instrument within states' RPSs. RECs are created when one MWh of renewable electricity is produced, and while details vary by state, a power producer is typically allowed to purchase RECs to meet some portion of their RPS requirements. In many, cases RECs are allowed to flow across state lines. Thus, the implementation of an RPS policy fundamentally increases the value of renewable energy generation. Thus, one plausible explanation for this result is that RPS have lead to increases in renewable generation not only in the states where RPSs are adopted, but also in other states that can produce renewable energy for the purpose of selling the RECs. Because all of the specifications employed treat these non-RPS states as the control, there is no difference observed between these groups, but in reality, both groups might see increases in renewable electricity generation due to the implementation of RPSs. This same mechanism does not work across state lines, though, for electricity prices, as the states with RPSs are forced to purchases the relatively expensive RECs that lead to increases in electricity prices, and this increase in electricity price relative to similar states leads to decreases in emissions. Therfore, it is unlikely that the decrease in emissions observed is due to the renewable energy generation itself, but instead is through the channel of decreased electricity consumption due to higher electricity prices.

References

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