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Promoting Renewable Energy Generation in the United States: The Debate over Renewable Portfolio Standards

Joe Cerne
jcerne@pugetsound.edu

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Promoting Renewable Energy Generation in the United States: The Debate over Renewable Portfolio Standards

Joseph L. Cerne

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for a Bachelor of Arts degree

University of Puget Sound
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Abstract:

Incentivizing renewable energy growth in the 21st century is, and will continue to be, a highly debated topic. As of late, legislative initiatives have prompted the enactment of various renewable portfolio standards aimed at stimulating renewable energy growth. Using data regarding each state's energy production, this paper finds that there is no significant change in renewable energy output following the initiation of a renewable portfolio standard. We conclude that renewable energy growth is virtually unaffected by renewable portfolio standards and as such, we agree with much of the literature implying other means are necessary in order to adequately shift the energy portfolio of each of the United States.

Introduction

In the face of global climate change, states are attempting to switch to more climate-friendly energy sources. Human health hazards, greenhouse gasses, environmental quality concerns, and the future of the planet's ecosystem are often at the core of the debate. One measure currently under consideration to facilitate this switch is renewable portfolio standards.

A renewable portfolio standard (RPS hereinafter), also known internationally as a renewables obligation or a renewable electricity standard, is a requirement mandated by government (either state or national) that requires a specified percentage of total energy produced within a state to come from qualified renewable resources. Qualifying sources of energy for RPSs vary from program to program. Additionally, the percent of total capacity required to reach a standard varies as well. No two RPSs are alike, and the United States currently has thirty of the fifty states using RPSs to stimulate renewable energy development. The overarching goal of all RPSs is similar, they intend to stimulate market and technological development so that ultimately, renewable energy will be economically competitive with conventional forms of electric power. However, the effectiveness amongst the programs is not so similar. This paper assesses whether the renewable portfolio standards already adopted by thirty of the fifty states in the U.S. are effective at influencing a switch from fossil fuels toward renewable energy. First, we provide a brief overview of the main issues associated with renewable portfolio standards; followed by a review of relevant literature regarding RPS initiation, concluding with an analysis of the initiation of numerous RPS programs and an interpretation of those results in order to determine the RPS effectiveness.

Literature Review

There is considerable debate about whether RPSs are effective at stimulating renewable energy development in the United States. Many scholars argue that RPSs create numerous undesired consequences that must be borne by residents of the RPS state. Most of which continue to assert that an RPS is not an optimal tool for renewable energy production (Rabe 2007, Lyon & Yin 2007, Carley 2009). They argue that a nationwide RPS will artificially increase prices in the energy market and as such, put an undue burden on the poor (Rossi 2010, Michaels 2008, Palmer & Burtraw 2005). They say that any RPS will equate to a tax on the public and is merely a symbolic gesture from the government to move toward renewable energy. State governments gain support from environmental groups, and no longer face environmental backlash by simply initiating RPSs, whether or not they rigorously enforce them. Several states have been criticized for their lax penalties for failing to meet the goals, and others have set goals at levels that are of almost no change from current norms. Similarly, they all argue that current RPS programs are inefficient and essentially inequitable responses to GHG's (greenhouse gasses). Specifically, Michaels (2008) even states that initiating a RPS would create an, "ultimately dysfunctional distraction from real problems," asserting that there are much more effective ways of changing energy norms in the U.S.

Palmer & Burtaw (2005) say that a nationwide RPS would increase electricity prices and reduce natural gas generation, and not affect coal generation. Since coal is nearly the cheapest of all fossil fuels, it will be the hardest to replace by profit maximizing energy suppliers. Natural gas tends to be more costly than coal across the US, therefore it is first to be replaced upon RPS initiation. The problem with this is that when compared with one another, coal use is much more of a pollution problem than natural gas use is. While natural gas is by no means an entirely clean

or renewable fuel source, it is still far cleaner than coal. Therefore, RPSs essentially displace a relatively better fuel, having the opposite of desired effect.

An additional argument against adopting an RPS is that of unequal cost distribution, and the unfair or "free-riding" advantage. Some states are more capable of producing renewable energy, and as such, it will be more efficient for them to initiate RPSs and lessen their environmental impact. Even so, being that there will be a positive externality with this change, nearby states will receive some parts of the health and environmental benefits (Palmer & Burtraw 2005, Rossi 2010). The general free-riding argument says that anytime someone is able to benefit from resources, goods, or services without paying for the associated costs, they are subsequently free riding towards the given benefit at the expense of others. With renewable portfolio standards, initiating a statewide policy is difficult, and requires many legislative agreements that do not come cheaply. Furthermore, the cost of new energy facility installation for energy manufacturers is an additional cost that must be borne by residents within the RPS state. Therefore, the time, energy, and money required to institute and comply with an RPS is extremely high. While it would be optimal on energy generation terms for all fifty states to adopt similar renewable portfolio standards, it may not be cost-effective. Some states are at an advantage to meet the RPS requirements (say 15% renewable output by 2040) because they have a geographical advantage and will have to bear significantly less costs of installation than other states due to their innate ability to capture certain renewable energy. It is common knowledge that renewable energy varies with geographic region. The Pacific Northwest is uniquely suited for hydroelectricity production, while not so much for solar generation. Similarly, the South and Southwest regions of the U.S. are prime areas for solar power, while other regions such as the Midwest would excel using wind power. This imbalance leads to an unfair burden on some

states that are not equally able to produce energy through renewables, as due to the non-uniform cost distribution, argued by these same authors. Some states facing more severe health and environmental problems due to fossil fuel use may have a higher incentive for RPS mandate creation, but may instead wait for a nearby state to adopt such policies, as they will receive partial benefit from the increase in environmental quality without bearing the associated costs.

Conversely, on the side of pro-RPS, lay numerous supporting authors (Bernow et al. 1997, Cooper 2008, Menz & Vachon 2006, Nogee et al. 2007, Yin & Powers 2010). Specifically, Nogee et al. (2007) use the EIA's (Energy Information Administration) NEMS (National Energy Modeling System) program to model data and determine that if states adopt RPS programs it will provide essential economic and environmental benefits to all involved. However, one difficulty in determining relative 'success' of programs is the unique nature of each RPS. Each state RPS is unique, and there are no set standards for what a "successful" RPS looks like. Some states have seemingly increasing amounts of renewable energy production following RPS initiation, while others have no significant change (Carley 2009). The specific RPS design features are essential in the state-by-state analysis, and as such are crucial in determining the success of a program (Yin & Powers 2010).

Other scholars acknowledge the success of some statewide RPS programs, yet question whether it is applicable for all states to adopt such standards (Ohler 2007, Fischer 2006, Wiser et al. 2005, Fershee 2008). As previously mentioned, not all state programs currently in place are alike. Therefore, the components that can make up a successful RPS program vary and can make it tough to discern what elements are needed to create a successful RPS in the future (Wiser et al. 2005). Fischer (2006) argues that the elasticity of the aggregate supply curve of non-renewable energy sources in the economy is the determining factor in the success of RPS programs.

Similarly, Ohler (2007) points to some potentially successful renewable energy types that would be neglected in a RPS due to their lack of availability for immediate use.

A Renewable Portfolio Standard may be applicable for some states and provide a relatively realistic goal to shift energy sources. However, only with the right components will it be economically efficient in moving the United States as a whole towards a more energy independent and fossil-free nation (Fershee 2008). As such, in this paper we attempt to discern whether the individual states that currently use RPS programs have experienced a significant increase in renewable energy production following the initiation of the RPS. Consequently, we find whether nearby states would benefit from initiating their own attempt at an RPS to promote renewable energy use.

The aim of this paper is to discern whether the initiation of a statewide renewable portfolio standard has a statistically significant effect on renewable energy production within that state. Much literature is in debate over the impact that renewable portfolio standards have on renewable energy production levels. In this paper, we go through "before," "during," and "after" scenarios of each state that has initiated a RPS since 1990, in order to discover whether the states have observed an increase in renewable energy production following the initiation of a RPS. To solidify our findings, we break down the United States into four regions, Northeast, Midwest, South, and West, similar to the US Census Bureau, in order to evaluate the effectiveness of RPSs at stimulating renewable energy growth nationwide, and to account for geographical differences between the regions that may affect specific state's ability to produce renewable energy.

Data & Methodology

Twenty-nine states have adopted RPSs since the year 1990, along with another adoption in 1983. This paper analyzes twenty-nine states from the year 1990 to 2011 as shown in table 1

below. The RPS data come from the Database of State Incentives for Renewables & Efficiency website, a government run website that focuses on the renewable initiatives taking place throughout the US.

Table 1. Summary of Renewable Portfolio Standards Initiation, Target Date and Target Goal

States with Renewable Portfolio Standards	RPS Initiation Date	Target Date	Target Goal (% of state energy production)
Arizona	1996	1999	15
California	2002	2003	33
Colorado	2004	2007	30
Connecticut	1998	2000	27
Delaware	2005	2007	25
Hawaii	2004	2005	40
Illinois	2007	2008	25
Kansas	2009	2011	20
Maine	1997	2000	40
Maryland	2004	2006	20
Massachusetts	1997	2003	25
Michigan	2008	2012	10
Minnesota	1994	2002	25
Missouri	2008	2011	15
Montana	2005	2008	15
Nevada	1997	2001	25
New Hampshire	2007	2008	23.8
New Jersey	1999	2001	22.5
New Mexico	2000	2002	20
New York	2004	2006	30
North Carolina	2007	2010	12.5
Ohio	2008	2009	12.5
Oklahoma	2010	2015	15
Oregon	2007	2011	25
Pennsylvania	1998	2001	18
Rhode Island	2004	2007	15
Texas	1999	2002	5
Washington	2006	2012	15
Wisconsin	1998	2000	10

Source: (U.S. Department of Energy

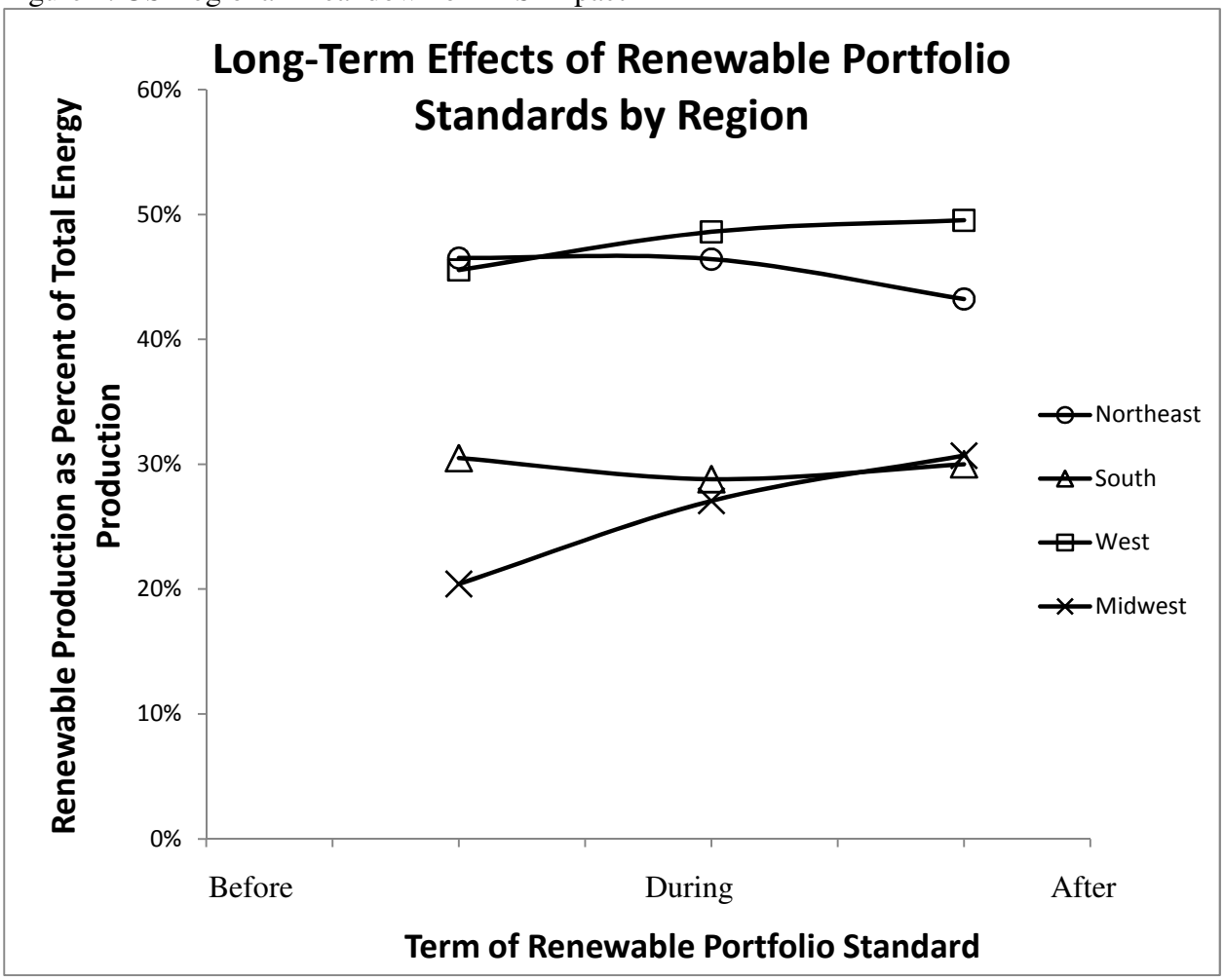
*Iowa initiated their RPS in 1983; due to missing data they have been omitted from this table

**District of Columbia & Puerto Rico also not included due to missing data

These data come from renewable energy production levels from the time of 1990-2011 for all states with an RPS (any state to have initiated an RPS, whether or not it is still in place); this serves as our dependent variable. These data will be the primary determinants of the success of an RPS, as it is the total energy production from all combined renewable energy sources from each state. The energy data were obtained from the US Energy Information Administration website, which provides yearly data for each state on the level of energy production from all types of energy sources.

By overlaying the data and including each state's renewable output level (taken as a percentage of total energy output) in one continuous trendline, we observe what happens to each state's renewable energy production leading up to the RPS, during the RPS, and following the target end date of the RPS. With this, as in Figure 1 below, we see how each of the four regions of the US was impacted during all three stages in comparison to one another. The four regions are designated by the US Census Bureau as follows: The Northeast (Connecticut, Maine, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island), The Midwest (Illinois, Kansas, Michigan, Minnesota, Missouri, Ohio, Wisconsin), The South (Delaware, Maryland, North Carolina, Oklahoma, Texas), and the West (Arizona, California, Colorado, Hawaii, Montana, Nevada, New Mexico, Oregon, Washington). Figure 1 shows the prolonged changes in renewable energy production to those regions as a result of the RPS initiation.

Figure 1. US Regional Breakdown of RPS Impact



Renewable production as a percentage of total energy production is used to account for large differences in total energy output between states. Some states, such as Delaware, produce extremely small levels of energy compared to California. However, on a percentage basis, Delaware uses more energy from renewables relative to any other source. By using production in percentage terms, we can account for this large difference in total production and measure only the change in relative renewable energy.

Figure 1 shows each region's renewable energy production as a percentage of total energy production, while appendices A-D provide a breakdown of energy production in each US

region during the three RPS time frames. The production levels are graphed over a three period time series of, "before, during, and after" representing the time before the RPS was initiated, the time during the RPS, and the time following the RPS leading up to current energy levels. The data are also listed in table 2 below as the specific breakdown of renewable production as a percent of total energy production in US.

Table 2. Breakdown of Renewable Production as Percent of Total Energy Production

Region	Before	During	After
Northeast	46.52%	46.43%	43.24%
Midwest	20.42%	27.06%	30.70%
South	30.49%	28.81%	30.00%
West	45.56%	48.61%	49.54%

Table 3 below describes the breakdown of renewable energy production as a percent of total energy production for every state that has enacted a renewable portfolio standard since 1990 (29 states in total). This breakdown represents the average level of renewable production before any RPS was in effect, compared to the sustained long term impacts of that RPS.

Table 3. Renewable Production as Percent of Total Energy Production

	State	Before	During	After
Northeast (1)	Connecticut	32%	36%	14%
	Maine	76%	100%	100%
	Massachusetts	59%	52%	44%
	New Hampshire	31%	26%	31%
	New Jersey	16%	11%	7%
	New York	53%	43%	45%
	Pennsylvania	4%	4%	4%
	Rhode Island	100%	99%	100%
Midwest (2)	Illinois	6%	9%	12%
	Kansas	3%	12%	12%
	Michigan	16%	22%	22%

	Minnesota	35%	41%	58%
	Missouri	25%	45%	45%
	Ohio	6%	10%	11%
	Wisconsin	52%	50%	53%
South (3)	Delaware	100%	100%	101%
	Maryland	19%	15%	18%
	North Carolina	30%	25%	25%
	Oklahoma	2%	4%	4%
	Texas	1%	1%	2%
West (4)	Arizona	15%	18%	15%
	California	23%	25%	27%
	Colorado	2%	2%	3%
	Hawaii	100%	100%	100%
	Montana	12%	10%	11%
	Nevada	74%	92%	94%
	New Mexico	0%	0%	1%
	Oregon	98%	100%	100%
	Washington	85%	91%	95%

Furthermore, an econometric analysis based on the combined renewable production data for all 29 states through the Stata Statistics & Data Analysis software, helps to determine whether there was a statistically significant increase in the level of renewable energy production during the time of the renewable portfolio standard. We create a dummy variable called, 'RPSDummy' in which a one is placed in every year that an RPS is in effect. By regressing the state renewable energy production as a percent of total production upon it, the goal is to determine whether or not renewable energy production was spurred during the time of the RPS. Additional state dummy variables are included in the regression as well in order to provide a more holistic view of the impact that RPSs have across states in each of the four US regions. The purpose of using dummy variables is to attempt to capture the effect of the RPS standard in each of the specific states.

Furthermore, to avoid perfect multicolinearity and the dummy variable trap, Washington State has been omitted from the regression and is to be used as the comparison state. It was chosen as the comparison because it lies around average in terms of RPS length, stringency, and total energy produced, serving as a middle ground to examine the data from. The same methods were used to regress regional breakdowns in renewable energy production as well.

From these variables we estimate the equation:

$$Y_i = \beta_0 + \beta_i \Sigma^{28}_{i=1} D_i + \mu$$

Results & Implications

The results from the various methods of analysis are mixed. From the US breakdown provided in figure 1, we see that the initiation of an RPS causes an increase in renewable energy production in the West and Midwest, but neither in the Northeast nor the South. For instance, states like Arizona experience short-term growth during the term of the RPS but then fall back to pre-RPS production levels following termination of the program. Meanwhile, states like Minnesota experience extraordinary growth during the RPS term as well as beyond the target end date. Furthermore, states such as Kansas experience growth during the term of the RPS, and remain constant at those production levels in the years following the target end date. Table 2 provides valuable information for the study in that we can assess regional differences in RPS success. Because different regions have varying renewable production capabilities, this table allows us to compare states within each region against one another in order to account for differences in production ability. Appendices A-D provide visual representation of this data as well. Consequently, most states in the West region should be similarly capable of producing renewable energy and therefore serve as good comparison states against one another. The same holds true for the remaining three regions. Table 2 suggests that even when accounting for

differences in regional ability, renewable portfolio standards remain collectively ineffective at stimulating significant levels of renewable energy production. While some states, such as Maine in the Northeast region, increase significantly throughout all terms of the study, similar states in the same region have falling levels of renewable production. It should be noted however, that in some regions one state's large success or failure, may disproportionately affect the results of that regions as a whole and should be taken into consideration when viewing the regional breakdowns.

To account for large discrepancies between states in the same region such as those listed above, table 3 and the state-by-state breakdown is useful. Overall, through the grouped trendline analysis, it appears that although some states have significantly positive repercussions from initiating renewable portfolio standards, the same holds for negative repercussions.

For the econometric analysis, table 4 below shows the significant Stata regression results using state renewable energy production as a percent of total production as the dependent variable and the RPSDummy, as well as each of the twenty-nine state dummies as the independent variables. OLS regressions administered using renewable energy production levels in trillions of BTU (British thermal unit) as the dependent variable, do not prove to be significant. Additional regressions incorporating lag variables are also insignificant.

Table 4. Regression Results for State Renewable Production (% of Total Production)

Renewable Production (% of Total Production)	Coefficient (P-Value)	Renewable Production (% of Total Production)	Coefficient (P-Value)
RPSDummy	0.014 (0.045)	Montana	-0.75 (0.00)
Arizona	-0.71 (0.00)	Nevada*	0.0016 (0.938)
Califomia	-0.62 (0.00)	NewHampshire	-0.56 (0.00)
Colorado	-0.84 (0.00)	NewJersey	-0.75 (0.00)
Connecticut	-0.63 (0.00)	NewMexico	-0.86 (0.00)
Delaware	0.14 (0.00)	NewYork	-0.37 (0.00)
Hawaii	0.13 (0.00)	NorthCarolina	-0.58 (0.00)
Illinois	-0.791 (0.00)	Ohio	-0.79 (0.00)
Kansas	-0.83 (0.00)	Oklahoma	-0.84 (0.00)
Maine	0.059 (0.004)	Oregon	0.12 (0.00)
Maryland	-0.68 (0.00)	Pennsylvania	-0.83 (0.00)
Massachusetts	-0.35 (0.00)	RhodeIsland	0.13 (0.00)
Michigan	-0.70 (0.00)	Texas	-0.85 (0.00)
Minnesota	-0.40 (0.00)	Wisconsin	-0.34 (0.00)
Missouri	-0.58 (0.00)	Constant	0.86 (0.00)
R-squared .9671			
F-stat 615.55			
No. Obs. 638			
* Indicates insignificant			

The RPSDummy variable is significant at the ninety-five percent, and twenty-seven of the twenty-eight states are statistically significant at the ninety-nine percent level. By observing the coefficients on the significant variables we again observe mixed results. Some states show increasing levels of renewable energy during the term of an RPS, shown by the positive sign on

the coefficient, and yet others hold negative signs and thus experience decreasing levels of renewable energy compared to Washington. The RPSDummy coefficient shows that with the existence of an RPS, on average a state can expect to see a 1.4% increase in their renewable energy output (as a percentage of their total energy output). The R-Squared value of .9671 demonstrates that 96.71% of the dependent variable can be explained by the independent variables in the regression. Furthermore the F-statistic of this analysis is 615.55 and the P-Value is 0.045 solidifying the results in saying that there is a less than 5% chance the results occurred by accident. Therefore, when assessing the statewide success of RPS mandates, we can conclude that they do not significantly affect most states renewable energy production.

Similar to the statewide analysis, we conduct regional OLS analyses to differentiate regional effects of RPS mandates. Table 5 represents the regional analysis of the Midwest as it is the only statistically significant region in the US.

Table 5. Regression Results for Regional Renewable Production (% of Total Production)

Renewable Production (% of Total Production)	Coefficient (P-Value)
Midwest RPSDummy	0.104
	(0.01)
Constant	0.215
	(0.00)
R-squared	.0413
F-stat	6.55
No. Obs.	154

With a P-Value of 0.01 we can say with 95% confidence that a state in the Midwest will increase their renewable energy production (as a percent of total production) by 10.14%. Since only seven of the eleven states in the Midwest region currently have RPSs in place, our results

imply that the other four states (Indiana, North Dakota, South Dakota, Nebraska, and Iowa) would moderately benefit from the initiation of an RPS.

The three other US regions provide insignificant results, so we fail to reject the null hypothesis in these situations, saying that RPSs do not have an impact on renewable energy production. One, two, and three-year lag variables were included in other regressions to account for time discrepancies between RPS initiation and production levels, but those are insignificant as well. Additionally, all four regions, the Midwest included, are insignificant when using actual production levels in trillions of BTU as the dependent variable.

Conclusion

By comparing states grouped from different regions, we aim to provide a more holistic view of the impact that RPSs have on renewable energy production throughout the US. The interpretation of RPS data through grouped trendlines is unique in this field of research. It is not a typical approach to interpretation, and provides a new point of view for this subject.

As a collective, between the econometric analysis and grouped trendlines, we observe mixed results, and as such, the effectiveness of renewable portfolio standards throughout the US is not clear. Mixed results from each of the regions, as well as from each individual state comparison, further discourage the effectiveness of the standards. There is no single statistic provided by either data sources that can point to the total success or failure to promote renewable energy production. However, by observing the overall trend in production levels from state to state, as well as from region to region, we begin to see that in most cases the initiation of a renewable portfolio standard does not significantly increase the level of renewable energy usage in the long run.

These results agree with the side of authors who do not believe that RPS programs alone are enough to significantly influence the level of renewable energy production in a given state. To improve upon these findings it would be important to complete further research into each state's alternative compliance payment structure in order to assess the stringency of each program. The overarching stringency, as well as other enforcement mechanisms would be useful to address in an econometric analysis. Potential in-depth case studies of state such as Maine, Missouri, and Nevada would also shed light on the RPS debate due to their unique high levels of success.

Works Cited

Bernow, S., Dougherty, W., & Duckworth, M. (1997). Quantifying the impacts of a national, tradable renewables portfolio standard. *The Electricity Journal*, *10*(4), 42–52. doi:10.1016/S1040-6190(97)80558-1

Carley, Sanya. "State renewable energy electricity policies: An empirical evaluation of effectiveness." *Energy Policy* 37.8 (2009): 3071-3081.

Cooper, C. (2008). A National Renewable Portfolio Standard: Politically Correct or Just Plain Correct? *Electricity Journal*, Pg. 9

Fershee, J. P. (2008). Changing Resources, Changing Market: The Impact of a National Renewable Portfolio Standard on the U.s. Energy Industry. *Energy Law Journal*, *29*(1), 49–77. Retrieved from http://ezproxy.ups.edu/login?url=http://search.ebscohost.com/login.aspx?direct=true&db=bth&AN=32482999&site=ehost-live&scope=site

Fischer, C. (2006). How can renewable portfolio standards lower electricity prices. *Resources for the Future Discussion Paper, Resources for the Future, Washington, DC*. Retrieved from http://www.rff.org/Documents/RFF-DP-06-20-REV.pdf

Lyon, T. P., & Yin, H. (2007). Why do states adopt renewable portfolio standards? An empirical investigation. *An Empirical Investigation (May 2007)*

Menz, Fredric C. and Stephan Vachon. 2006. The effectiveness of different policy regimes for promoting wind power: Experiences from the states. Energy Policy 34: 1786–1796

Michaels, R. J. (2008). A National Renewable Portfolio Standard: Politically Correct, Economically Suspect. *Electricity Journal*, Pg. 9

Nogee, A., Deyette, J., & Clemmer, S. (2007). The Projected Impacts of a National Renewable Portfolio Standard. *The Electricity Journal*, *20*(4), 33–47. doi:10.1016/j.tej.2007.04.001

Ohler, A. (2007). The Effects of Renewable Portfolio Standards on Renewable Energy Sources. In *2007 Annual Meeting, July 29-August 1, 2007, Portland, Oregon TN* (No. 9869). American Agricultural Economics Association (New Name 2008: Agricultural and Applied Economics Association)

Palmer, K., & Burtraw, D. (2005). Cost-effectiveness of renewable electricity policies. *Energy Economics*, *27*(6), 873–894. doi:10.1016/j.eneco.2005.09.007

Rabe, Barry. "Race to the Top: The Expanding Role of U.S State Renewable Portfolio Standards." Sustainable Development Law & Policy, Spring 2007, 10-16, 72

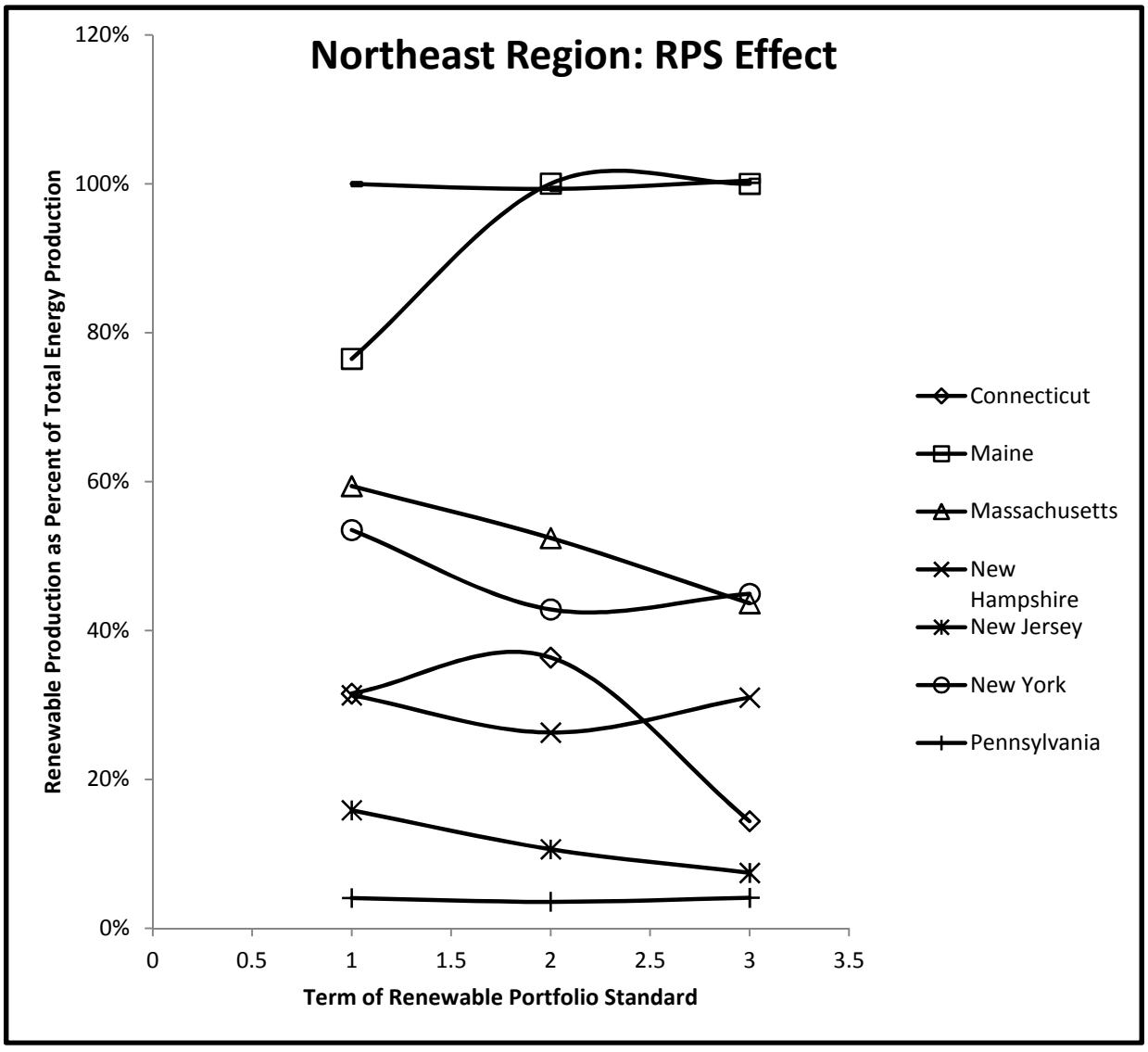
Rossi, J. (2010). *The Limits of a National Renewable Portfolio Standard* (SSRN Scholarly Paper No. ID 1646123). Rochester, NY: Social Science Research Network. Retrieved from http://papers.ssrn.com/abstract=1646123

U.S. Department of Energy, Energy Efficiency & Renewable Energy. (2013). *Database of state incentives for renewables & efficiency*. Retrieved from website: http://www.dsireusa.org/rpsdata/index.cfm

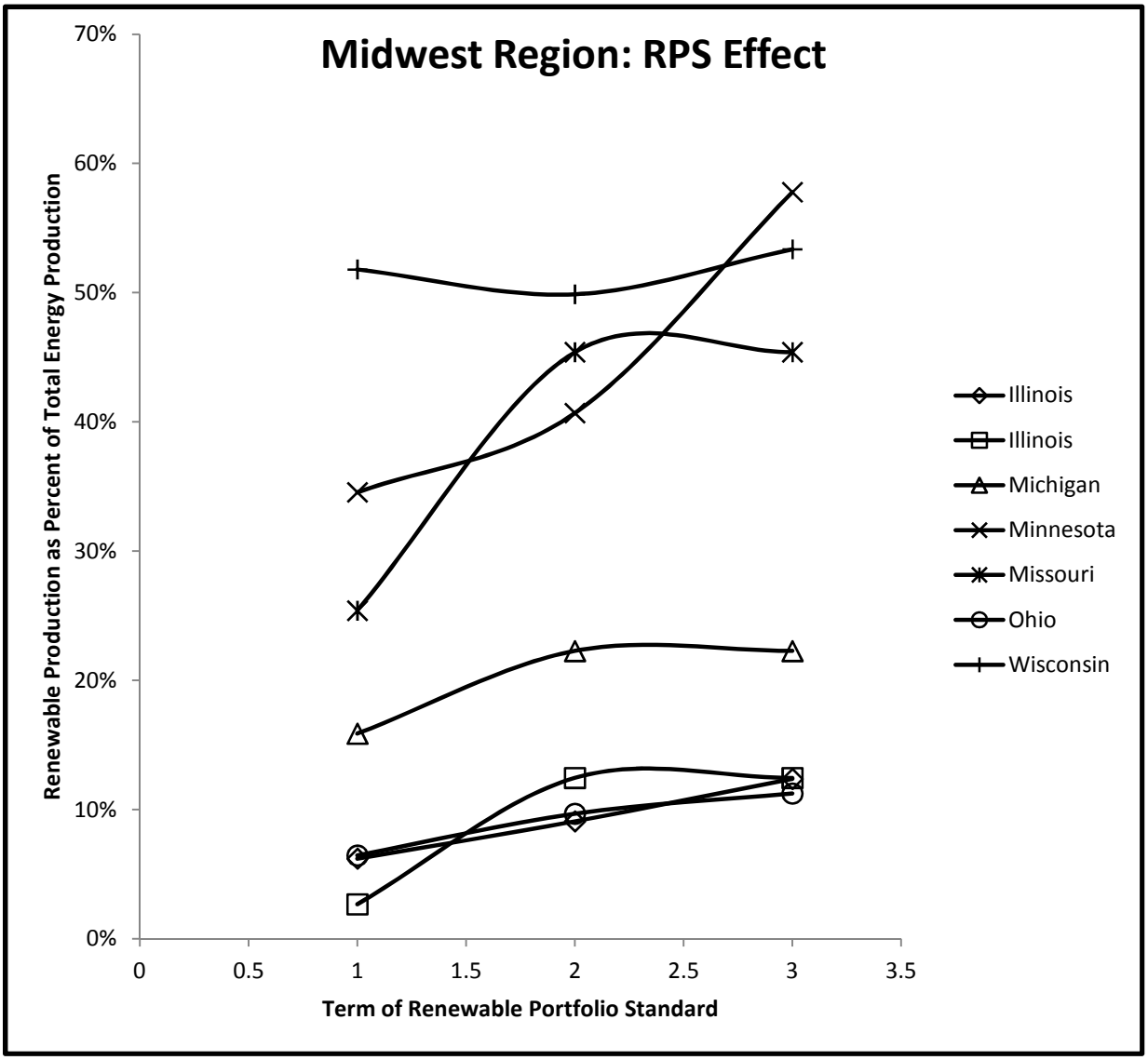
Wiser, R., Porter, K., & Grace, R. (2005). Evaluating Experience with Renewables Portfolio Standards in the United States. *Mitigation and Adaptation Strategies for Global Change*, *10*(2), 237–263. doi:10.1007/s11027-005-6573-4

Yin, H., & Powers, N. (2010). Do state renewable portfolio standards promote in-state renewable generation□. *Energy Policy*, *38*(2), 1140–1149. doi:10.1016/j.enpol.2009.10.067

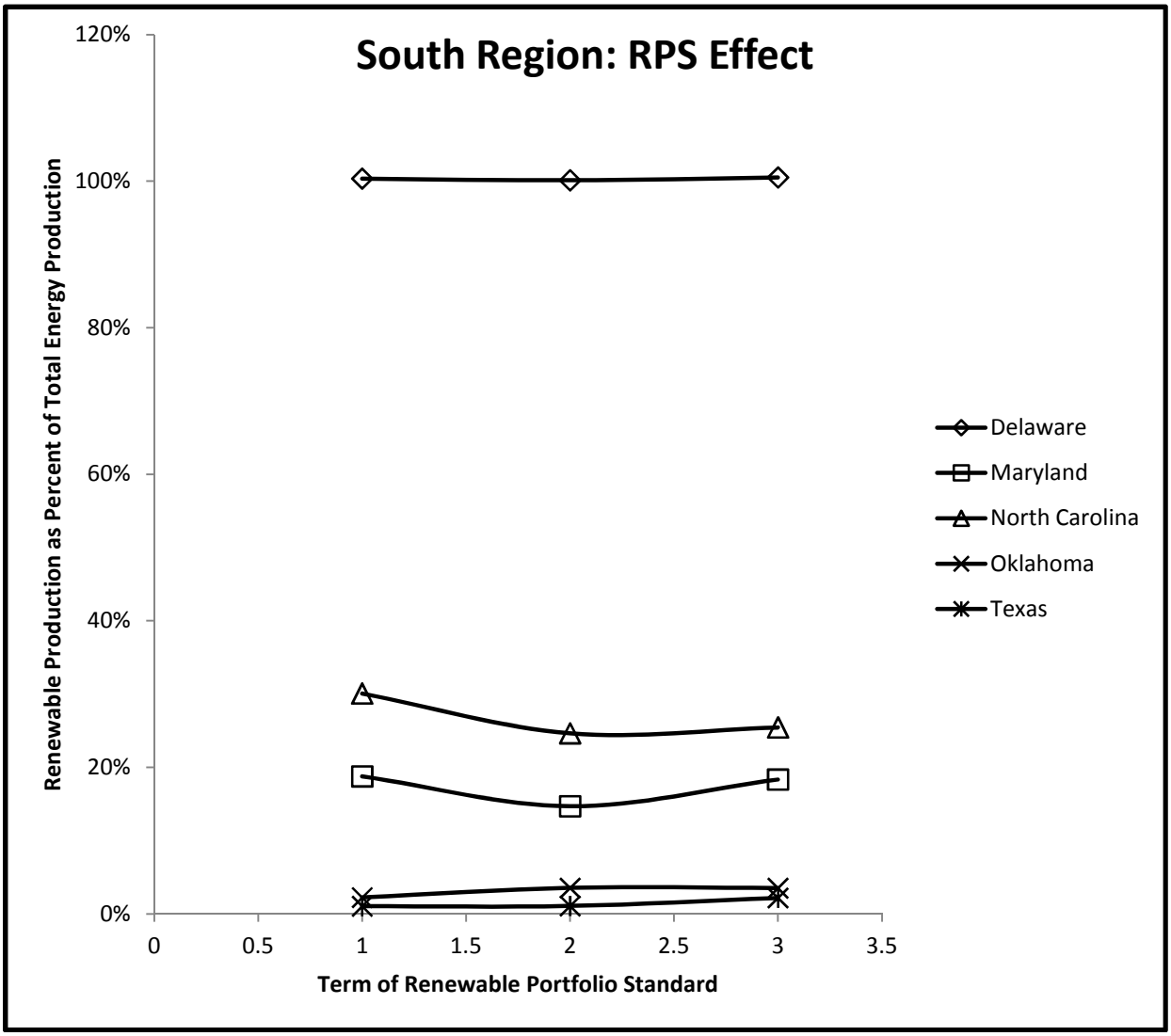
Appendix A


Northeast Region: RPS Effect
Renewable Production as Percent of Total Energy Production
120%
100%
80%
60%
40%
20%
0%
0
0.5
1
1.5
2
2.5
3
3.5
Term of Renewable Portfolio Standard
Connecticut
Maine
Massachusetts
New Hampshire
New Jersey
New York
Pennsylvania

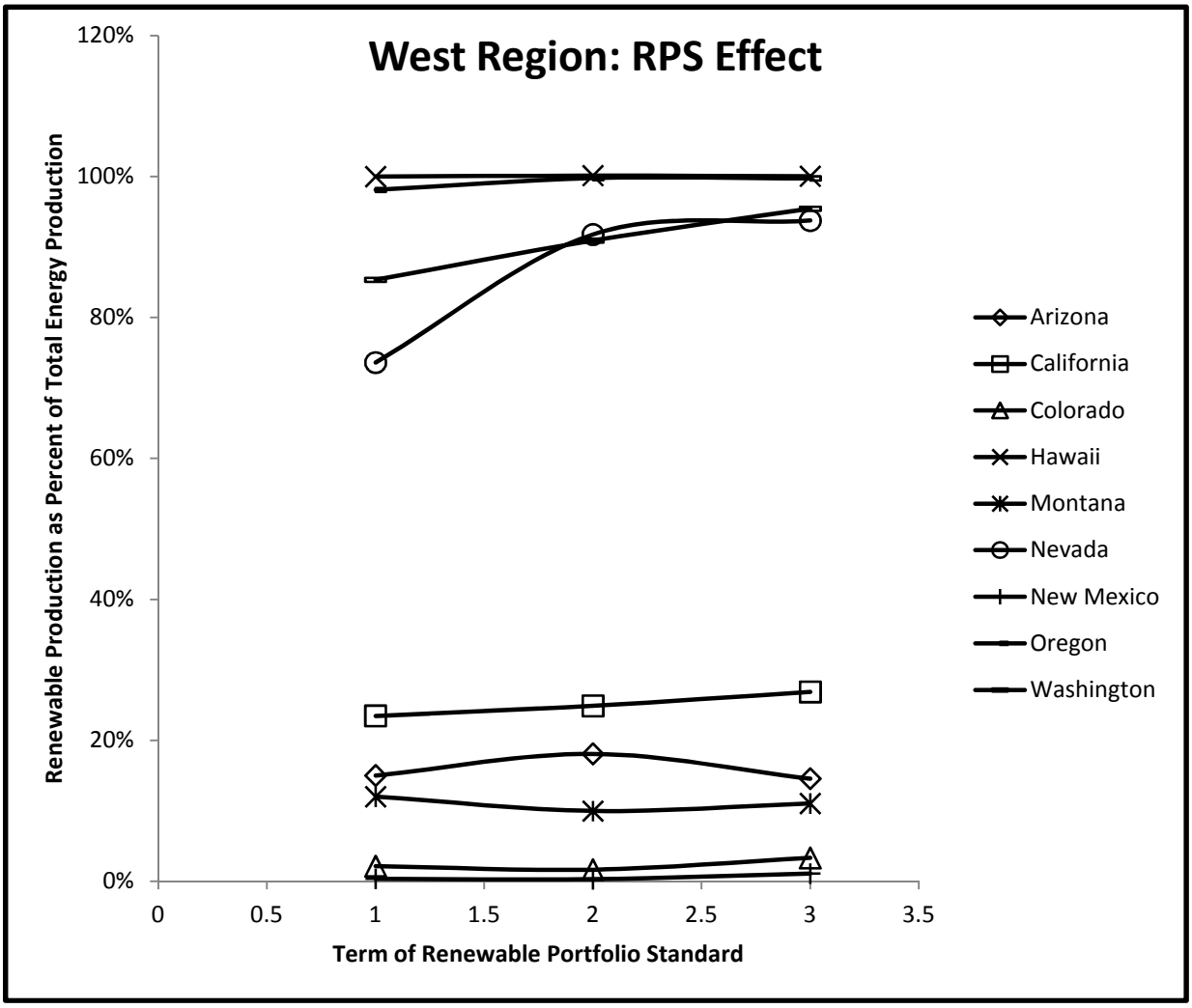
Appendix B


Midwest Region: RPS Effect
Renewable Production as Percent of Total Energy Production
70%
60%
50%
40%
30%
20%
10%
0%
0
0.5
1
1.5
2
2.5
3
3.5
Term of Renewable Portfolio Standard
Illinois
Illinois
Michigan
Minnesota
Missouri
Ohio
Wisconsin

Appendix C


South Region: RPS Effect
Renewable Production as Percent of Total Energy Production
120%
100%
80%
60%
40%
20%
0%
0
0.5
1
1.5
2
2.5
3
3.5
Term of Renewable Portfolio Standard
Delaware
Maryland
North Carolina
Oklahoma
Texas

Appendix D


West Region: RPS Effect
Renewable Production as Percent of Total Energy Production
120%
100%
80%
60%
40%
20%
0%
0
0.5
1
1.5
2
2.5
3
3.5
Term of Renewable Portfolio Standard
Arizona
California
Colorado
Hawaii
Montana
Nevada
New Mexico
Oregon
Washington