Explaining the Diffusion of the Energy Efficiency Resource Standard (EERS) Across States

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ABSTRACT

Twenty-eight states have adopted an energy efficiency resource standard (EERS). The EERS can greatly improve the market for energy efficiency in the adopting states, resulting in significant reduction in energy consumption and greenhouse gas emissions. This study considers the factors driving the adoption of EERS. I employ a policy diffusion model to better understand what leads to the diffusion of the EERS. The diffusion model is largely used and accepted in the policy literature as an effective means to better understand policy adoption across governments. The model takes into account economic competition and social learning among states, as well as the states internal factors. The primary focus of the study is on how economic competition among states drives the adoption of an EERS. The study finds that the likelihood of adopting an EERS is significantly influenced by competition among states, particularly when taking into account quality of life and business operating costs factors. With better understanding of the EERS policy diffusion process, state legislators and advocates will be able to set realistic expectations related to the likelihood of policy adoption and act strategically in pursuing specific policy options.

Introduction

Reducing energy consumption is an enormous area of opportunity for the United States, resulting in improved air quality, a reduction in greenhouse gases and decrease in business operating costs. According to a study by McKinsey and Company (2009, 2013) the United States has an opportunity to reduce energy consumption by 23% annually by 2020 resulting in savings of over $1.2 trillion dollars and a reduction of greenhouse gases by 1.1 gigatons annually. Energy Efficiency Resource Standards (EERS) have been cited as one of the key policy tools to reduce energy consumption in states. An EERS establishes mandatory electric and/or natural gas savings targets for a utility or state entity to promote end-user energy saving improvements. These standards are largely responsible for much of the action taken by utilities to implement energy efficiency and demand side management programs (DOE, 2010). With so much opportunity for energy efficiency and attention paid to the adoption of the EERS, it is important to understand the key factors that drive the adoption of these policies among states. Understanding why states choose to adopt clean energy policy and the factors behind the adoption will allow key decision makers to set expectations related to the passage of clean energy policy and be more strategic in determining where to focus resources.

This study will use a policy diffusion model, considering economic competition and social learning among states, as well as a state's internal determinants to develop a better understanding of why states adopt EERS policies. The diffusion literature is well established and has been used to help explain and predict policy adoption in a variety of policy areas (Daley and Garand, 2005; Berry and Berry, 1999). Components of the policy diffusion methodology have been deployed when studying the adoption of renewable portfolio standards (Huang et al 2007, Vachon and Menz, 2006, Padilla and Serrano, 2006) and sustainable energy portfolio standards (Chandler, 2009). However, key differences exist between renewable portfolio standards and EERS policies, making the development of a new diffusion model necessary. A state's adoption of an RPS is largely dependent on the availability of specific natural resources of the state, i.e. wind, sun, or water, while EERS is not dependent on natural attributes and can be deployed in any state. (Nadal, Shipley and Elliott, 2004).

One of a state's primary goals is to attract and retain productive capital and resources to ensure it has the appropriate tax base to provide services it to its residents. Two factors of competitiveness are quality of life and business operating costs. For this study, I focus on air quality and electricity prices as two factors that affect state competitiveness. Anecdotally, it has been stated that clean energy policies are adopted to reduce operating costs and emissions. Therefore, I test to see whether states with poorer air quality, compared to other states, and states with higher electricity costs, compared to other states, are more likely to adopt an EERS.

Literature Review

Twenty-eight states have adopted an EERS[1]. The first state to adopt an EERS was Texas in 1999, and the latest state to adopt was Wisconsin in 2011[2]. A wide range of goals are set throughout these states. EERS goals can be established for a specific reduction in energy sales (electricity and natural gas), reductions in load growth and/or reductions in system demand by a specific percentage. These goals can be met with a variety of market-based mechanisms and can result in a cost effective energy efficiency portfolio that lowers consumption, saves consumers money, reduces greenhouse gas and air pollution emissions and creates jobs.

Renewable Energy and Energy Efficiency Adoption Studies

Much of the work concerning the adoption of clean energy policy has looked largely at renewable portfolio standards (RPS) and focused on internal factors of the state. Studies find that more liberal states and environmental group presence increase adoption of RPS policies (Vachon and Menz, 2006; Huang et al 2007), strong state economy and more state renewable resources drives adoption, while affluence of population decreases the likelihood of adoption if the RPS is mandatory (Huang et al 2007, Padilla and Serrano, 2006). Industrial concentration has no influence on adoption (Huang et al, 2007; Vachon and Menz, 2006), while larger existing fossil fuel generation portfolios tend to increase adoption (Vachon and Menz, 2006). Renewable energy potential of state is mixed in determining policy adoption (Huang et al, 2007; Vachon and Menz, 2006); poorer air quality is associated with increased adoption of RPS (Lyon and Yin, 2007); and Sustainable Energy Portfolio Standard (SEPS) adoption is driven by the previous adoption of other states (Chandler, 2009). The findings of these studies likely apply to factors associated with EERS adoption. However, they are largely cross-sectional, meaning they focus on one point in time and do not consider factors affecting adoption over time. Further, in all cases, but Chandler, these studies do not account for the activities of other states or the interaction among states, which is an important factor in understanding policy adoption.

[1] Due to the similar nature of an EERS and RPS, they are combined into one policy in some states. Nevada, North Carolina and Hawaii. I include all states that have adopted since 1999. This would include voluntary and mandatory EERS, as well as underfunded states.
[2] Maine's recent announcement is not a new adoption.

Diffusion Literature

To understand how policies diffuse across states and why states adopt the policies they do, it is important consider a variety of factors. Policy-diffusion models are typically employed to study how external factors, economic competition and social learning among states, as well as internal determinants of the state, influence policy choice by state governments (Berry and Berry 1999).[3] Policy diffusion is the pattern "by which organizations adopt a particular innovation across both space and time" (Mooney 2001). The policy-diffusion model suggests that states pay attention to the actions of other states to learn from the policy experiment of other states, to react to externalities, and possibly to emulate successful policies. The model proposes that as the number of neighboring states adopting a policy increases, non-adopting states see the policy as inevitable, increasing the likelihood of adoption (Ka and Teske 2002).

Economic competition. The economic competition component of the policy diffusion models claims that diffusion occurs because of competition among states and public pressure to adopt successful policies (Boehmke and Witmer, 2004). States compete with other states to gain an economic advantage by attracting good things and repelling bad things, and because of the fear of losing jobs, taxes and business to other states (Bailey and Rom 2004; Mooney 2001). A basic premise of the policy diffusion model is that because states must compete for human and capital resources, they have an incentive to pay attention to and keep up with other states in their policy choices (Bailey and Rom 2004). More specific to energy efficiency, the environmental policy literature finds states compete through the adoption of environmental policies they feel will make them more attractive to business (Potoski and Woods, 2002; Daley and Garand, 2005).

The severity of a policy problem relative to other states will influence the adoption of policies. States look to other states to determine how their problems stack up with other states. They compare their policy problem to other states and determine adoption, based on the relative severity of specific policy problems. If the states are facing similar problems they will adopt similar policies. If the state's problem is not as severe as competing states then the likelihood of adoption will decrease. If the state has a higher level of severity in comparison to other states, the likelihood of adoption will increase.

State competitiveness is dependent upon quality of life (Mathur and Stein, 2005) and business cost of operations (Michielsen, 2013). Increasingly, states are competing to ensure they are providing a higher quality of life than other states. They fear losing productive capital or being unable to attract productive capital. Globalization, deindustrialization and technological innovation are transforming the economy of urban areas from manufacturing to more service-oriented economies (Katz 2006). In a more service-oriented economy, skilled labor plays a pivotal role in economic development, consequently, the focus for cities and business is to attract these workers. Skilled labor and the service industry are much more flexible and are more likely to locate in places that have a better business climate and good quality of life; they tend to balance economic opportunity and quality of life when selecting a place to live and work (Mathur and Stein 2005). Quality of life issues are provided through amenities, such as good air quality, that attract skilled labor and drives inter-regional shifts of the population (Arora et al 2000; Glaeser, Kolko, Saiz, 2000). Air quality plays a role in the retention and recruitment of resources to a state (Smith and Huang 1995). One of the stated reasons for adopting energy efficiency policies is to improve air quality by reducing emissions (Brennan and Palmer 2012;

[3] Ideology, interest group influence, state wealth, etc.

Nadel 2006). Thus, it is important to see if air quality is driving adoption of EERS. If so, it would be expected that states with poorer air quality, compared to other states, are more likely to adopt EERS.

Hypothesis 1: States with air quality that is worse, relative to other states, are more likely to adopt an EERS.

A business's expenditures on energy are an important factor in determining location (Michelsen, 2013; Gerlagh and Mathys, 2011). Higher prices for the factors of production will result in higher costs of production and lower output levels. Energy efficiency programs are found to decrease costs of operation and improve business productivity, particularly states with a tight energy market (Geller and Attali, 2005). States adopting EERS policies may be more attractive to industry than states that have not adopted an EERS. Because business locates and relocates using energy costs as a motivator, it would be expected that states with significantly higher energy costs relative to other states, are more likely to adopt an EERS.

Hypothesis 2: States with higher energy costs, relative to other states, are more likely to adopt an EERS.

Social learning. States not only compete, but they also learn from each other. States make decisions by analogy; they compare themselves with other states, and use proximate states as a frame of reference to learn about particular policies. (Berry and Berry 1999). They may focus on proximate states due to similarities in values, familiarity, cross-mixing of population and media, and ease of communication (Mintrom and Vergari 1998; Mooney 2001). Information gathered from familiar and similar states reduces uncertainty of policy outcomes and may increase likelihood of adoption (Boehmke and Witmer, 2004). Further, as time passes, the potential adopter is able to learn from those that have adopted and make changes to the policy to meet the state's needs (Shipan and Volden, 2008). The expectation is that as the number of states adopt EERS increases, among states that have not yet adopted the likelihood of adoption increases.

Further, it has been suggested that states look beyond their neighbors to learn about specific policies. Grossback et al. (2004) find that states pay attention to and learn more from other states that are ideologically similar. The similarity helps the adopting states to reduce uncertainty as to where the issue/policy fits along the liberal-conservative continuum. By taking this into account, state policy makers are more certain that by passing this policy, they will have less pushback from their constituents. I anticipate, specific to the EERS, states are looking to the most recent adopters of EERS to determine whether or not this policy is suitable for their state. If the most recent adopters are ideologically similar to those considering adoption, then the likelihood will be higher for those states to adopt.

Internal determinants. Internal factors within the state influence policy adoption. A useful way to conceptualize the influence of internal determinants is with Mohr's (1969) theory of organizational innovation. The framework suggests that diffusion depends on the motivation to innovate, the obstacles to innovation and the availability of resources to overcome obstacles. The motivation and obstacles to adopt are dependent upon the presence and strength of interest groups, state political ideology, public opinion, and the severity of the policy problem (Shipan and Volden 2006; Grossback et al. 2004; Boehmke and Witmer 2004). The availability of resources and state capacity are determined by the wealth of the state and the professionalization of the government (Shipan and Volden 2006).

Specific to motivation, severity or need within a state is a significant internal determinant for policy adoption (Daley and Garand 2005). In this study, severity is measured by the state's electricity generation reserve margin. At present, many of the FERC regions, exceptions being California ISO and ERCOT, are comfortably above their reserve margin target (EIA 2012). However, in recent history a region's reserve margin has dipped significantly below these targets (EIA 2014). In some cases the reserve margin has approached 8.4% in the SPP, 10.5% in the SERC, 11.6% in the WECC, 13.8% in the NPCC, etc. We anticipate that as the near term forecasts for reserve margin dip below the reserve margin target, the likelihood of policy adoption will increase for states that are experiencing this decrease.

It is also important to consider what the barriers facing policy adoption and the resources available to overcome these barriers (Berry and Berry 1999). Barriers may include political culture and state ideology. I test the barriers to adoption by considering the state's ideology. The literature finds that states that are more liberal are more likely in general to have greater levels of policy adoption (Grossback et al. 2004). Previous studies focused on RPS find that party dominance by conservatives is negatively related to adoption of RPS's, and states with a Democratic dominated legislature are more likely to adopt RPS policies (Huang et al 2007). Resources may allow the state to overcome obstacles. Resources include state wealth, legislative professionalism, and bureaucratic capacity. The expectation is that states with greater financial resources have a better capacity to develop and implement policies (Daley and Garand, 2005).

Research Design

To conduct the analysis, I focus on states adopting an EERS between 1999 and 2011. In 1999, Texas was the first state to adopt an EERS. The list of EERS adopting states was found primarily through the DSIRE database and the ACEEE July 2013 Policy Brief on EERS adoptions (ACEEE, 2013). I use a Cox Proportional Hazards Model; a standard approach in studying state policy adoption (Box-Steffensmeier and Jones 2004). In my model the dependent variable is adopt state policy or not adopt state policy in a particular year. The dependent variable is coded "0" for states that do not adopt a policy and "1" for each that adopts. The process of duration models works by assuming that the first state to adopt a policy begins the diffusion process and is, therefore, not included in the model. The states that have not adopted are "at risk" of adopting during each year in the pool. During this time, there are 28 adoptions. The model assumes that each state adopts once and there is no repeat adoption.[4]

Independent Variables

State competition and the adoption of policies to maintain competitiveness is the primary focus. I argue that an important driver for the adoption of EERS is concern over not retaining productive labor and capital and becoming less competitive. State competitiveness will be measured by looking at air quality as the quality of life variable and price of electricity as the cost of doing business in a state variable. I contend the likelihood of adopting an EERS is partially dependent on how well states compare to each other based on these two factors.

I develop an air quality relative severity measure (air risk ratio). It measures the severity of air quality in one state compared to the air quality in other states over this study period. Severity is based on the EPA Greenbook Non-Attainment Areas (EPA, 2013). The Greenbook identifies, by county, the percent of a state's population that lives in an 8-hour ozone non-

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[4] It is not the intent of the model to account for amendments or justifications over this time period. It simply is predicting whether an EERS is adopted or not.

attainment area. The numerator is the percent of the population in the state that lives in an ozone non-attainment area. In the denominator is the average percent of the population of all other states living in an ozone non-attainment area. A score of one indicates that the state has similar air quality severity as other states. A score of less than one indicates the state has air quality that is better than all other states. A score greater than one indicates the state has air quality that is worse than the all other states. The expectation is that states that score one or less are less likely to adopt EERS policies[5].

The second competitiveness variable is the relative cost of energy (kWh ratio). States with high kWh rates are at a competitive disadvantage to states with lower kWh rates. I gather the average cost of electricity per kWh per state from the US Energy Information Administration (EIA) Electricity Data Browser (EIA 2014a). For kWh relative severity ratio, the numerator is the yearly average kWh rate for the state. The denominator is the yearly national average kWh rates for each year in the study period. KWh ratios above one indicate that state's price is higher than national average and kWh scores below one indicate that state's price is below national average.

I control for social learning effects. I measure social learning with the commonly used proportion of proximate adopters variable (Boehmke and Witmer 2004). Because this is an energy efficiency related policy, I define proximate adopters as those states that fall within the same Energy Efficiency Partnership region, i.e. NEEP, NEEA, MEEA, SWEEP, etc. The expectation is that as the number of adopting states within these regions increase, the likelihood of non-adopting states adopting the policy increases.

The other learning variable measures the similarity of political ideology among states. Grossback et al. (2004) argue that similarity among states' ideology significantly influence diffusion. I use their continuum measure to determine the difference in ideology among states[6]. The ideology data is from an ideology database by Berry et al (2010).

I develop measures for the internal determinants of the states that may influence adoption. State government ideology influences state policy-making behavior (Berry et al 2010). Berry et al (2010) developed a dynamic measure of state ideology that varies across states and time. This is a composite measure taking into account what party has control over state governing institutions and the ideology of state political parties. This measure is scored to where the higher the score, the more liberal the state. I expect that there are likely to be fewer barriers to policy adoption in liberal states than in conservative states; liberal states are more likely to pursue more government policy (Daley and Garand 2005).

The severity of the policy problem can also be a strong motivator for pushing a state to take policy action. In this instance, we anticipate that states that are facing reserve margin issues would be looking for opportunities to reduce energy consumption and demand and improve their reserve margin (EIA 2013). For each state, I determine severity of reserve margin issues with a dichotomous variable. A state is coded 0 if the reserve margin trend is improving, indicating there is no near term reserve margin issues. A state is coded as 1 if the reserve margin trend is worsening at the time of adoption, indicating a near term problem with the reserve margin.

Obstacles to innovation are determined by the fiscal health of the state, the availability of

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[5] I also test whether regional air quality differences plays a significant role in the adoption of EERS. From the analysis it appears states are paying attention to how they compare across the country rather than how they compare to proximate states in their air quality non-attainment status.

[6] Ideological Distance = ABS([(MostRecentAdopterIdeo. + AllOtherAdopterIdeo.) / 2] – PotentialAdopter)

slack resources. The expectation is higher state per capita revenue, the more likely policy adoption will occur. I calculate the state per capita revenue using data from U.S. Census State Government Finances[7] for each year in the study period. Both models are provided below.

Air Quality: $h_i(t) = h_0(t) \exp(\beta_{\text{air risk ratio}} + \beta_{\text{proportion of proximate adopters}} + \beta_{\text{ideological distance}} + \beta_{\text{government ideology}} + \beta_{\text{reserve margin}} + \beta_{\text{state wealth}})$

Cost of electricity: $h_i(t) = h_0(t) \exp(\beta_{\text{kWh ratio}} + \beta_{\text{proportion of proximate adopters}} + \beta_{\text{ideological distance}} + \beta_{\text{government ideology}} + \beta_{\text{reserve margin}} + \beta_{\text{state wealth}})$

Results

Table 1 provides the two separate competition models. In the first model, the Air Risk column, I test how the air quality of a potential adopting state, compared to other states, influences the likelihood of adoption. The model supports hypothesis one.

Table 1. Economic competition and policy adoption (coefficients) – N:49

Independent variable	Air Risk	kWh Risk
Economic competition	.588(.280)**	5.11(1.57)***
Proximate adopters	14.25(3.03)***	-19.25(4.21)***
Ideological difference	-.362(.140)**	-.260(.145)*
Government ideology	.387(.142)***	.28(.147)*
State wealth	.0001(.0004)	-.0002(.00048)
Reserve margin	1.02(.557)*	1.25(.609)**

*P<0.1,**P<0.05,***P<0.01

The Air Risk coefficient, .588, is significant and indicates that relatively bad air quality leads to a greater risk of adoption. The hazard ratio in the model is greater than one (Haz. Ratio=1.80)[8] indicating that the risk of adoption increases as air quality worsens relative to others. Further, I find that 77% of the states with an air risk ratio greater than one adopted. In contrast, 44% of the states with air risk ratio less than one adopted.

To further demonstrate how the difference in relative air quality influences adoption, I present Figure 1, a Cox proportional hazards regression. This graph demonstrates two things. First, over time, as would be expected, the likelihood of adoption increases. An increasing hazard function, shown on the y-axis, demonstrates a greater risk of adoption. More importantly, the risk of adopting an EERS among states with no population in non-attainment areas (AirRisk=0) is lower compared with states that have some to all of the population living in non-attainment areas. The larger the population living in a non-attainment zone, the greater risk of adopting. States that are at the mean of Air Risk (AirRisk=.92), have 20% to 25% of its population in non-attainment areas; Air Risk score one standard deviation above the mean (AirRisk=2.07), have 65 to 70% of its population in non-attainment areas; Air Risk score two standard deviations above the mean (AirRisk=3.48) have 90% to 100% of its population in non-attainment areas.

[7] http://www.census.gov/govs/state/

[8] I do not include the table with the hazard ratios. Rather, I only include the coefficients table. The more interesting information is the substantive explanation in the text along with the graphs below.

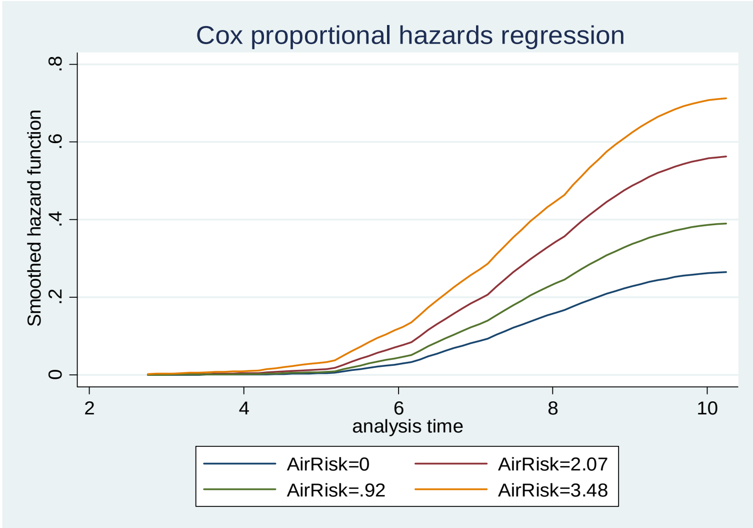

Figure 1. Cox proportional hazards regression for air risk ratio. *Source:* Dillingham, 2014

Figure 2 shows the probability of adopting an EERS for states with good air quality to those with poor air quality. The model suggests that the probability of adoption increases by about 25% when going from states with good air quality (0.92) compared to those with poorer air quality (3.48), an Air Risk ratio two standard deviations above the mean.

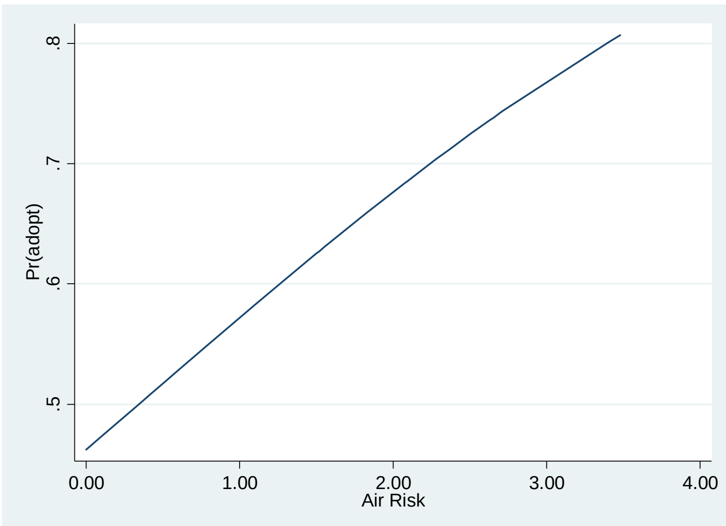

Figure 2. Probability of adopting with air risk ratio. *Source:* Dillingham, 2014.

The control variables also tell a compelling story. The ideological distance variable was in the expected direction and significant. Potential adopters are more likely to adopt if the previous adopters, particularly the most recent, adopters are ideologically similar. The proportion of proximate adopters variable was significant, but had a minimal effect on the model. Although it is a miniscule effect it is important to understand what it is indicating. A hazard ratio less than one (6.44×10^{-07}) indicates that as the number of proximate adopters increases, the risk of additional adopters in the region decreases. This may suggest that states are taking a more national view of adopting an EERS versus focusing on the activity of states within its region.

The strong Air Risk result, measuring air quality of adopting state compared to all other states, provides similar evidence that states may be looking nationally for cues to adopt. The government ideology variable is also significant indicating that more liberal states have a greater risk of adopting an EERS. The State Per Capita Revenue variable was not a significant predictor indicating that the economic resources of the state, at least measured in this manner, is not an important factor determining adoption. The reserve margin trend indicates that the risk of adopting an EERS increases as the reserve margin of a state is anticipated to decrease the following year. However, this variable is not significant at the p>.05 level.

The second competition model, provided in table one, considers how a state's cost of electricity relative to other states influences adoption of an EERS. I use the same model as the Air Risk model, substituting out Air Risk for the kWh risk ratio. The model supports hypothesis two. The kWh ratio, 5.11, is significant and in the expected direction. Further, 75% of the states with kWh ratio greater than one adopted an EERS compared to 47% adopting with a kWh ratio less than one. The hazard ratio is greater than one for the kWh ratio (Haz. Ratio=167.26) indicating that the likelihood of adoption increases as relative price increases.

Graph 3 presents a Cox proportional hazards regression for the kWh ratio risk model. The graph indicates that over time the risk of adoption increases. Further, the graph allows for a comparison of how the difference in electricity costs across states will influence adoption. The graph displays states with kWh prices lower than the national average of $0.06 (kWhratio=.62), states with a kWh prices equal to the national average of around $.084 (kWhratio=1), states with kWh prices higher than the national average; one standard deviation above the mean of $0.116 (kWhratio=1.34) and two standard deviations above the mean of $0.15 (kWhratio=1.68).

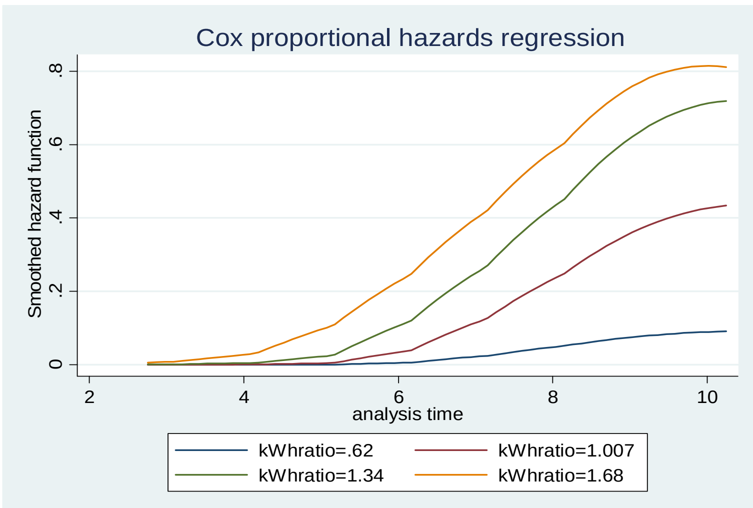

Figure 3: Cox proportional hazards regression for kWh ratio. *Source:* Dillingham, 2014

Figure 4, indicates that the likelihood of adoption is about 17% higher for states that have relatively higher electricity costs, measured as the kWh ratio one standard deviation above the mean, compared to states with kWh prices that match the national average. States with prices in the $.15 range, two standard deviations above the mean, had a 30% greater risk in adopting an EERS than those states at the national average.

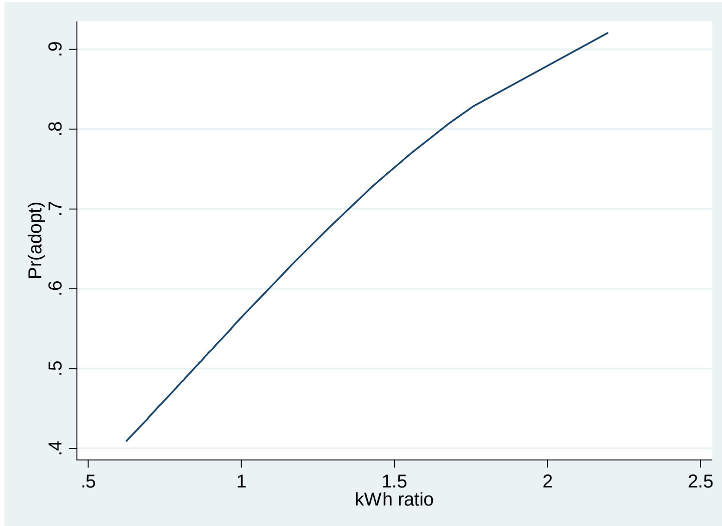

Figure 4: Probability of adoption for kWh risk ratio. *Source: Dillingham, 2014*

The control variables stay relatively consistent compared to the Air Risk model and can be similarly interpreted.

Conclusion

Economic competition among states does matter when considering the adoption of an EERS. States that have poor air quality relative to other states and higher electricity costs relative to other states are more likely to adopt an EERS. The expectation is that by adopting this policy energy consumption will decrease resulting in improved air quality and lower operating costs. This study provides vital information to policy makers to help them better understand what factors drive the adoption of energy efficiency policy. These decision makers will be able to use this information as they develop expectations regarding the likelihood of passing a policy, as well as inform their policy making strategies.

For those states that have adopted, there is a diversity of requirements and expectations placed into the standards. The next phase of this research will be to look more specifically at individual components of the policies that have been adopted and determine how they have been changed or customized for the needs of the states. Further, upon establishing a pattern of change and innovation, it will be possible to determine how the effectiveness of these policies change over time and in different settings.

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