Reid Dorsey-Palmateer
Dissertation Abstract

# THREE ESSAYS IN THE ECONOMICS OF ELECTRICITY

## Chapter 1: Effects of Wind Power Intermittency on Generation and Emissions (Job Market Paper)

This paper examines how the intermittency of wind power affects electricity generation and the resulting emissions. Wind energy differs from conventional fossil fuel because it is not perfectly dispatchable. Potential wind generation varies with wind conditions and these wind conditions are not perfectly forecastable. While wind power reduces the required amount of fossil fuel generation and its associated pollution, because the electricity grid is operated with the goals of both low cost and system reliability, the intermittency of wind power could cause the electricity grid to be operated in a different manner with impacts on pollution. Wind intermittency could affect emissions by shifting the generation mix between dirtier and less flexible coal generation to cleaner and more flexible natural gas generation. Additionally, varying output levels can lower the efficiency of fossil fuel generators.

Using hourly pollution and generation data from Texas, the state with the highest wind generation capacity, I test how wind power intermittency affects the generation mix of fossil fuel generation and the resulting effect on emissions. Variation in wind output levels are associated with a shift towards natural gas generation. Overall, this shift towards a cleaner fuel source dominates any fall in generator-level efficiency and results in reduced emissions. After controlling for the reduction in overall fossil fuel requirements and explicit intermittency variables, additional wind power is still associated with an additional shift away from coal and to natural gas and a resulting reduction in emissions. This additional intermittency effect falls over the 2011-2013 period examined as wind power forecasting accuracy increases.

These results have implications for optimal wind power subsidy policy. While wind power produces no emissions, unlike many other power sources, its intermittency imposes costs on the electric grid because grid operators must be prepared to compensate for expected or unexpected changes in wind generation. While this imposes a financial cost, it also results in additional emissions reduction, the value of which should be incorporated into the measures of external costs and benefits of wind generation. Furthermore, subsidies for wind power have historically been determined by the amount of electricity generated. However, if the motivation behind wind subsidies is to reduce pollution, the contribution of any given wind turbine towards wind intermittency and the resulting impact on external costs and benefits should be incorporated into the subsidy amount.

## Chapter 2: Transition Policy in Retail Electricity Deregulation (In progress)

Instead of having retail electricity prices be provided from a single provider with the price set through regulation, some states have deregulated this market, allowing consumers to choose between multiple retail electricity providers set their own prices. States that have deregulated their retail electricity sector have used different regulatory policies during the transition period and have experienced a variety of outcomes with respect to market concentration and price.

I examine the impact of various approaches to regulatory policy during the transitional period, most notably the effect of price controls on the default electricity provider and of increasing the price sensitivity

of consumers, on the evolution of prices and market concentration over time. Demand parameters for consumers are estimated using Texas data through indirect inference while distinguishing between unobserved firm quality and consumer inattention. Using these estimated parameters, the effects of selected transitional regulatory policies are studied using a dynamic model of firm pricing behavior. Alternative transitional policies include varying the nature of temporary price controls on the incumbent firm as well changing consumer search behavior through increasing awareness of the retail market and making search and switching easier.

**Chapter 3: Curtailment of Wind Generation and Implications for Transmission (In progress)**

Even though wind power can be generated at effectively zero marginal cost and does not create air pollution, the amount of wind power generated can be less than the potential wind generation given wind conditions and wind turbine placement. The amount of curtailed wind power must be instead obtained from an alternate, more expensive source. This has been an issue in Texas, where much of the recently installed wind generation capacity has been in the western, less populated part of the state. The majority of wind curtailment appears to be due to congestion on transmission lines heading to the more populated areas. Exploring alternate explanations for curtailment, I examine data on bids into the wholesale electricity spot market in Texas, and find that wind power is voluntarily curtailed on occasion, however this is not common. I also fail to find evidence that avoiding incurring startup costs is significant contributor to wind generation curtailment.

In Texas, this wind curtailment has fallen substantially over the past several years due to construction of additional transmission capacity at large expense. When wind generation is curtailed, alternate generation sources must compensate for the reduction in wind generation. This can result in increased emissions from electricity generation and can affect the wholesale cost of electricity. Using CEMS emissions data and detailed generator-level data from Texas including wind curtailment, I estimate these environmental and financial benefits from reduced wind curtailment.