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How does uncertainty in renewable energy policy affect decisions to invest in wind energy?

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ABSTRACT

This paper examines the impacts of uncertainties in U.S. renewable energy policy on the investment decisions of renewable electricity producers. We develop and solve a dynamic optimization model to understand how investment in wind energy depends on market and policy uncertainties. These uncertainties include the federal government's uncertain decision about the continuation of the Production Tax Credit (PTC) policy and the stochasticity of prices in the market for Renewable Electricity Credits (RECs). Our results show that investors require higher REC prices to invest without the PTC policy. Results contribute to our understanding of how policy uncertainty affects the profitability threshold required for investors to commit to renewable energy projects.

1. Introduction

Renewable energy resources have significant potential to supply energy, support energy security goals, and contribute to less carbon-intensive energy production. The United States, one of the largest electricity consumers in the world (EIA, 2012a), has been successful in increasing the share of electricity produced from renewable sources. In 2012, the largest share of US electricity generation capacity additions was coming from wind (EIA, 2012b). Wind is expected to contribute about 5% of total electricity generation in 2015, which makes wind the largest renewable resource in the US renewable energy portfolio (EIA, 2015). This significant increase in investments in wind energy can be attributed, in part, to supportive government policies at both state and federal levels. Wind has been the renewable energy resource that has benefited the most from these policies (Wiser et al., 2007).

Despite supportive federal and state policies, electricity production from renewables is still only a small fraction of the total energy supply in the United. There are several possible reasons. First, renewable energy may simply not be cost-competitive with energy from non-renewable sources given current technology and prices. Even when renewable energy is economically feasible, it takes time to develop the underlying infrastructure. Second, uncertainties about future prices and technology may dampen current investments even though investment in renewable resources would be wise if current prices and technology were sure to persist into the future. Third, if most of the incentives to invest in renewable energy come from government policy, investors may be concerned that these incentives may not last. This paper focuses on the third reason and asks how uncertainty in renewable energy policy affects investment decisions in wind energy in the United States. We focus on two important renewable energy policies that drive wind investments in the US: the federal Production Tax Credits Policy (PTC) and state Renewable Portfolio Standards (RPS) that provide the foundation for Renewable Electricity Credits (REC) markets.

We use real options theory (Arrow and Fischer, 1974; Dixit and Pindyck, 1993) to model the wind power investment decision under policy uncertainty. A few recent studies have used this framework to examine investments in renewable energy considering various sources of market and policy uncertainty: uncertainty in future carbon prices and climate policy (Fuss et al., 2008,

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2012; Reuter et al., 2012a,b), future fuel prices (Fuss and Szolgyaova, 2010; Lou, 2011), future pollution costs and pollution stock (Balikcioglu et al., 2011), and future renewable and non-renewable resource stocks (Mosino, 2012). We aim to contribute to this literature by examining investment thresholds of private power generating companies, given uncertainty about future renewable energy policy. We show how the relationship between the investment profitability threshold and policy depends on REC prices and REC price volatility. We begin with the policy background, and proceed to methods and findings. We then discuss the implications of our results and end with our conclusions.

1.1. Policy background

The federal government has promoted renewable energy through Production Tax Credits (PTC) since the passage of the Energy Policy Act in 1992. Investment in wind power is currently subsidized at $23 per megawatt-hour during the first ten years of a new renewable energy facility's operation. This subsidy covers almost one-third of the initial installation cost (Brown, 2012). Congress has repeatedly renewed these credits each time they were set to expire. Most recently, the PTC was set to expire on December 2013 and the projects that were installed before January 1, 2014 continue to receive these credits through 2016. However, it is still unclear whether the PTC incentive will be available for future wind projects (Barradale, 2010; Brown, 2012).

Fig. 1 shows the quarterly cumulative wind capacity and additions to wind capacity between the first quarter of 2008 and the first quarter of 2014. Although the cumulative wind capacity installations have substantially increased since the first quarter of 2008, several on-and-off periods in the PTC policy created volatility in the quarterly capacity installations. During the times when the federal government allowed the PTC policy to expire, or when the extension happened late, capacity installations were approximately 70–92% lower nationally. Fig. 1 shows that, in the first quarter of 2013, capacity installations dropped precipitously. This occurred after the government allowed the PTC to lapse in the last quarter of 2012. In the last quarter of 2014, just before the policy expired, investments were considerably higher. EIA also reported that approximately 40% of the wind capacity installations occurred just before the expiration of the PTC in the last quarter of 2012 (EIA, 2012b).

Individual states have instituted Renewable Portfolio Standards (RPS) programs in which a certain fraction of total electricity must be produced using renewable sources. Renewable Portfolio Standards programs are implemented with Renewable Electricity Credits (RECs), tradable commodities used to facilitate compliance with the renewable energy requirements provided by the RPS. RECs are earned by producing electricity from renewable sources as an attribute of the generated renewable electricity, and excess credits can be sold to firms that fall short in meeting RPS requirements. RECs have been one of the fundamental drivers of the private wind projects and have provided additional revenue for the producers (Cory et al., 2008). REC prices are determined in regional trading markets.

2. Methods

We model the decision to invest in renewable electricity using a discrete-choice dynamic optimization problem. The decision to invest in renewable electricity production from wind energy is considered to be irreversible. We assume that the representative investor is a price taker and that the capacity of the wind turbine model is not large enough to affect electricity or REC prices. The investor knows the current REC and electricity price and knows that the RPS goals need to be met in 20 years (Wiser and Bolinger, 2012). We assume that the investor faces fluctuating stochastic REC prices. We assume two uncertainties in our model: (1) annual prices of Renewable Electricity Credits (RECs) follow a stochastic process, and (2) the federal government may or may not choose to continue the PTC incentive when it expires at the end of each year. We assume that expected REC prices will settle into their long-term average values by the end of the time horizon because states will have met their RPS requirements and the supply of wind energy will have stabilized. Finally, the representative investor sells RECs for each unit of renewable energy produced from wind, with 1MWh = 1REC.

In our model, the representative investor maximizes the expected profits from producing clean energy from a particular wind project. In each period, the investor can choose either to invest in the wind project or not. We assume that the investor has

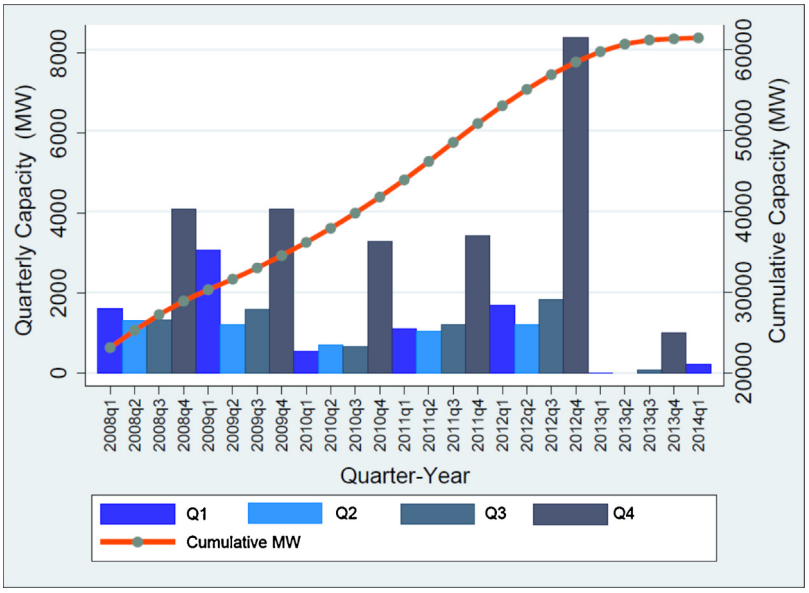

Fig. 1. Wind capacity installations between 2008 and 2014.