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CARBON PRICE AS RENEWABLE ENERGY SUPPORT ? EMPIRICAL ANALYSIS ON WIND POWER IN DENMARK

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Overview

In Europe, the coexistence of a common carbon market and national renewable support policies raises the question whether a carbon price alone could replace renewable energy support policies. What level of carbon price would be needed to achieve deployment comparable to that from existing renewable energy support policies? The purpose of the work presented here is to conduct an empirical analysis of the conditions that lead to wind energy deployment and from these results, to infer the carbon price level that would attain significant deployment. The analysis focuses on Denmark given electricity price and support policy changes over time. Econometric techniques are used to test the effect of these parameters on on-shore wind power deployment on a monthly basis on the time period 2000-2010. A discrete choice econometric model is used to analyse the observation or absence of observation of new turbine connections to the grid. From the results of the econometric analysis, a carbon price level that would attain significant wind power deployment is inferred. This equivalent carbon price is computed from a model of difference in profitability between renewable and fossil fuel technologies.

Method

Denmark is chosen for its long wind power history, the frequency of changes in the type and level of its wind support policies and the large amount of data available for wind energy. Since 2000, four policies have successively been in place: a feed-in tariff of 58€/MWh, then a premium regime of 13€/MWh associated with a cap on the total remuneration per unit of electricity produced (variable premium), then a fixed premium regime of 13€/MWh and finally a fixed premium of 34€/MWh. The observation of aggregate on-shore wind capacity in Denmark in parallel with the corresponding support policies shows a correspondence between the growth of capacity and the support scheme and suggests the existence of a support level threshold above which new turbines are connected to the grid. A discrete choice econometric model is chosen as an appropriate approach to explain the presence or absence of observations of new turbine connection to the grid and take account of such a possible threshold effect. The model used is based on the profit function for wind energy. It takes account of the expected electricity price revenue, the support level and the investment cost for wind power. The decision is made to build new turbines only if the expected profit from it is positive or equal to zero. The probit analysis allows testing the impact of each of these factors. Dummy variables are added to test the impact of the support policy type (feed-in tariff, variable premium or fixed premium). The support level needed to have a probability of 0.5 to observe connections of new turbines to the grid is quantified. The equivalence between carbon price and renewable support policies to cover cost differences between renewable and conventional technologies is then used to convert the results from the econometric analysis into a carbon price level, under revenue certainty equivalence.

Results

Results of the probit analysis on the observation of connection of new turbines to the grid indicate that the support level impact is dominant and that the influence of past electricity prices is limited and dominated by the support level. They also show that a feed-in tariff policy significantly brings in more wind than a premium policy but that a variable premium does not have a significantly different impact than a fixed premium. Initial investment cost impact is also dominated by the impacts of the support level and the feed-in tariff. The probability of connection of new turbines to the grid as a function of the policy type and the support policy is computed. It indicates that, on average, 22€/MWh is the support level needed, in addition to electricity price, to have a probability of 0.5 to observe connection of new turbines to the grid. On the basis of the equivalence between a support premium and a carbon price to cover the cost differences between renewable and fossil fuel technologies, the support level of 22€/MWh can be converted into an equivalent carbon price of 26€/ton if renewable energy competes with electricity production from coal or 46€/ton if it competes with electricity production from gas.

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