WIND POWER INNOVATION AND POLICY IN EUROPE: A PATENT DATA APPROACH

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Overview and Objective

The technological progress of renewable energy technologies such as wind power is commonly viewed as a key in the process towards a more sustainable and less carbon intensive energy use. At present the generation shares of renewable energy sources, even though increasing over time, remain limited. Given the implementation of sufficient technology support policies these shares can however increase substantially over time even if the current production costs of most renewable energy technologies are relatively high. An important policy criterion for these types of policy schemes, including tradable renewable energy certificates, feed-in tariffs, production quotas, and tax credits, is therefore the extent to which they spur technological innovation and thus stimulate further cost reductions in the renewable energy sector.

For this reason the effectiveness of these different policies in encouraging innovation in renewable energy technologies needs to be examined empirically in more detail. In this paper we investigate the effect of various renewable energy policies on innovation measured through patent activity in the wind energy sector. The choice of wind power is motivated by the fact that it represents a key energy supply technology in complying with existing and future climate policy targets, and there exists a wide variation of policies used worldwide to encourage wind power expansion. While previous research has frequently analysed the impact of different policies on the diffusion of wind power, less attention has been paid to the policy schemes' influence on innovation.

Methods

Given the need to find a reliable measure of technological innovation, patent counts, as an output measure, is a valuable source of information, since they reflect the innovative performance of a firm or economy in a way which is attractive to researchers (Griliches, 1990). Appropriate patents in a variety of subject areas can be identified by the use of the International Patent Classification (IPC) codes, developed at the World Intellectual Property Organisation. Based upon a literature review of technology progresses in the area of wind power, a set of keywords were identified for the study, that were used to determine the appropriate IPC codes which relate straight to renewable energy from wind power. Patent counts were generated for each IPC classification using the OECD Patent Database, and only patent applications that were derived from the European Patent Office (EPO) were included. Different policy indicators were then constructed using a database of public policies which aimed at developing renewable energy sources observed at the International Energy Agency (IEA). In the paper the analysis is conducted using patent data on a panel of European countries over the time period 1986-2010.

The dependent variable, patenting activity, is measured by the count of patent applications (claimed priorities) by inventor country. We specify a model in which patent activity in wind power is a function of, for instance, overall patent activity (as a proxy for the general propensity to patent), steel prices (the most important raw material in the production of wind turbines), electricity prices and a number of different public policy variables. In comparison to earlier research efforts (see in particular Johnstone et al., 2010) we pay considerable more attention to the identification of the public policy impacts. Specifically, we employ detailed data on policy support levels (per kWh) and distinguish between different types of support schemes (e.g., tradable renewable energy certificates versus fixed feed-in tariffs). We also address the impact of public R&D policy (drawing on the IEA database), and construct a knowledge stock, acknowledging both the depreciation of knowledge over time as well as the time lag between investment in public R&D and its subsequent addition to the knowledge stock. Also other types of policies (e.g., tax credits etc.) are investigated employing a dummy variable approach. In setting up the data set we are able to draw heavily on previous research on technology learning and R&D by the authors (see, for instance, Ek and Söderholm, 2010).

Given the count nature of the dependent variable, negative binomial and Poisson estimators are generally used to estimate the models (for details on count data models see, for example, Cameron and Trivedi 1998; Hausman et al. 1984). Generally, in count data the variance exceeds the mean (i.e., there is over-dispersion) and the traditional Poisson distribution, which is based on an assumption of equidispersion (i.e., mean and variance are equal) report non-correct standard errors of the parameter estimates. For this reason, negative binomial estimates are generally preferred to Poisson regression model, and this is also the approach taken in this study. A fixed effect approach is employed, thus addressing any unobserved country-specific influences over time.

Results

The empirical results indicate that the extent to which different wind power policies tend to stimulate innovation activities, and the analysis involves a number of model specifications differing in terms of how the different policy impacts have been operationalized. For instance, we explicitly test the hypothesis that the innovation impacts of different types of public support schemes for wind power will differ. Notably, the analysis permits a detailed assessment of the role of public R&D towards wind power in influencing patent activity in this sector. Unlike previous studies we also test whether the timing of public R&D versus public support schemes to the production of wind power has played a role in determining the propensity to innovate. For instance, technological progress requires both R&D and learning-by-doing, and for this reason R&D programs can typically not be designed in isolation from practical application. One could therefore anticipate the presence of synergy effects between R&D and direct production support, thus motivating the inclusion of policy interaction variables.[1]

Conclusions

This paper examines how effective different policies are in encouraging innovation in the wind power sectors in a cross-section of European countries over the period 1986-2010. The empirical findings highlight in particular the role of public policies, and in particular the design and the stringency of public support schemes and R&D policies in influencing wind power patent activity. The contribution of the paper lies primarily in its in-depth empirical efforts to address the impacts of different public policies, including test of different model specifications and important policy interaction effects.

References

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[1] The empirical discussion also addresses the role of private R&D, although we are not able to include this in the quantitative analysis.