THE EFFECTS OF POLICY UNCERTAINTY ON TECHNOLOGY DIFFUSION: WIND POWER IN ITALY

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Overview

European renewable energy policies are going through a period of changes, often unanticipated, which are likely to influence both long- and short-run decisions of investors in the sector.
The literature on innovation and diffusion has shown that uncertainty (for instance, on market prices, or technology costs) has a negative effect on technology adoption and use (Stoneman and Battisti, 2010). However, only a few contributions, so far, have attempted to clarify how the above finding applies to *policy* uncertainty and what are the consequences in terms of the diffusion of environmentally friendly technologies. Such studies adopt a real options approach and examine how the positive probability of a change in renewable energy or climate policy, at a given point in time, may affect a single investor's decision: overall, the standard inhibitory effect of uncertainty on investments is confirmed (among others, Boomsma et al., 2012 and Yang et al., 2008).
This work focuses, instead, on the diffusion pattern and considers a single Renewable Energy Source (RES) for power generation. The objective is to examine the effect of market environment characteristics, as well as the role of policy uncertainty on the adoption decision. Differently from previuos work, policy uncertainty is defined as a continuum of major and minor changes in the support scheme. Also, both the methodological approach and the data set are original. While the former is described below (see "Methods"), we recall here that the latter consists of all onshore wind plants connected to the grid between 1987 and 2014 in Italy. This is combined with information regarding institutional stability, investment costs, and presence of production-based support schemes.
Another original aspect of the work regards the conceptual model designed to capture the role of policy uncertainty. Specifically, we assumed that a first set of drivers of the diffusion of wind technologies comprises the well known effects of production-based *support schemes* (e.g., green certificates) which, together with *market-related characteristics* (e.g., investment costs) and *positive externalities* (e.g., learning effects), influence the decision to *invest* – adopt the new technology. Another driver influences, instead, the decision related to the timing of the *connection to the grid* - the time at which the new technology starts being used. This decision is attributed to the specific structure of the support scheme which is in place at the time of connection – as this is the event defining which support scheme is awarded to the investor. Accordingly, the conjecture is that policy changes affect the diffusion rate by inducing a strategic response in the timing of "first use" of the technology. Specifically, the expectation is that the effect of policy uncertainty is a clustering in the occurrence of first-use events, which leads to periods with high number of connections and periods with relatively few of them. Also, clustering of events is expected to be observable on a finer time scale than typically assumed in the study of diffusion paths (several years).

Methods

Whitin survival analysis, a point process perspective (that is, the idea that first-use events can be counted as times passes) is adopted. This allows to consider *Hawkes processes* (Hawkes, 1971), which are able to capture the potentially clustered nature of events. In this context, this corresponds to the irregular alternation of periods of peaks and drops in the number of connections to the grid. Applied to seismology, neural networks, reliability and, more recently, to finance, Hawkes processes assume the presence of contagion: past events increase the probability of events today (in time series econometrics, an analogy can be made to an autoregressive process). In our conceptual model, such a clustered proliferation of events is linked to (technology) policy uncertainty. The model is estimated via maximum likelihood, implemented in Matlab.

Results

A statistically significant effect of clustering is found, providing evidence that, independently of the size of the onshore wind installation, investors make policy-based decisions even in the short run (e.g., relative to the choice of the date of connection to the grid). Significant effects of the market environment characteristics on the (long-run) investment decision are also found. More precisely, in all model specifications the instability of the institutional setting (proxied by an index for economic policy uncertainty) has a delaying effect on the investment decision. The same happens for the proxy for investment costs (that is, a wind turbine price index computed from energy and material indexes). The presence of support schemes, driven by electricity demand (and proxied by GDP per capita), has, instead, an accelerating effect on the decision to invest in a wind technology, as expected.

These results are robust to the introduction of a variable capturing cumulated knowledge about the technology and, hence, a potential higher incentive to invest due to the possibility to learn from existing users. Such an effect is present when the model is estimated on the full sample, implying the presence of learning. However, the effect disappears when installations of capacity lower than 1 MW are excluded, suggesting that sourcing information about the technology from other users is important mainly for small investors, who are likely newer to the electricity sector.

Conclusions

Results from the estimated Hawkes models indicate that, despite wind technologies having become increasingly competitive with conventional ones, and despite the significant effect of market environment characteristics on the decision to invest, investors make decisions that are strongly policy-driven, even in the short run - that is, relating the date of first use of the technology. This leads to a diffusion path which is S-shaped in the long run, but shows also a distinctive clustering of events on a finer time scale.

These results are important in terms of policy implications. Indeed, the fact that all investors are able to react relatively fast to RES policy changes raises planning issues both from a technical and a government spending perspective. From the technical point of view, periods of high demand for the connection to the grid can create problems to the system operator. As far as government spending is concerned, given this high sensitiveness of investors to RES policy changes, choosing the timing for the actual implementation of such changes seems to be crucial.

Looking at future developments of this study, it is worth highlighting that, potentially, individuals could make multiple adoption decisions. This happens also in the considered sample. However, this work did not use this information. Instead, the focus was on drivers of diffusion external to individuals, as the main interest was in the fact that an adoption event occurred, independently of who actually made the investment. In other words, while they did not enter this study, the analysis of rank effects constitutes an interesting extension.

References

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