Do auctions promote innovation in renewable energy technologies? An empirical analysis of solar PV

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1. Motivations underlying the research

The descarbonisation of energy systems represents a key element of the energy transition which is needed to meet the Paris Agreement target. In 2015, governments agreed to limit global warming to 2 degrees, and preferably 1.5 degrees, below preindustrial levels. Renewable electricity technologies (RETs) are a main pillar of this decarbonised energy transition, together with energy efficiency. However, progress has been modest to date.

Solar PV, the focus of this paper, has experienced an impressive increase in deployment in the last decade, driven by the interactions between technology cost reductions, innovation and diffusion fueled by support schemes. The greater diffusion of the technology is a key factor behind these cost reductions. In turn, this diffusion has been driven by demand-pull policies, with administratively-set feed-in tariffs and feed-in premiums (ASFITs/FIPs) being the most popular instrument in this regard. ASFITs/FIPs have been superseded in the last years by auctions as the dominant scheme for RET deployment worldwide.

Such ambitious growth in the deployment of renewable energy capacity requires that different RETs are available at low costs in the next decades. In turn, this requires innovation, including technological innovation. Innovation is not a manna that comes from heaven, but it requires investment and support. A combination of supply-push (support for R&D) and demand-pull (support for deployment) has traditionally been considered as needed for innovation. According to the chain-linked model, the diffusion (deployment) of RETs influences previous stages of the technological change process. Therefore, an instrument which supports deployment can also be expected to influence innovative activities[c]. As auctions are the most widespread deployment support instrument today, and as innovation is needed, we may wonder about the impact of different support schemes (and, particularly, auctions) on innovation.

Indeed, the impact of auctions on innovation is unclear. Economists assume that auctions are not only good to limit the costs of support for renewable electricity, but that they also encourage innovation. It is often argued that the competitive pressures generated by auctions provide incentives to reduce costs and improve renewable energy equipment throughout the whole value chain, which leads to innovation. However, auctions may not score so well in encouraging innovation. While the positive impact of competition on innovation is undeniable, there are probably other mechanisms at play (the expectation of the existence of a market in which equipment developers can sell their innovative products, learning effects and sufficient profit margins which can be reinvested (by project developers and equipment manufacturers) in private R&D. In the past, auctions have led to non-negligible rates of non-completion and delays and to tiny profit margins. This limits the perspective of a future market for the technology, the existence of learning effects and reinvestments into private R&D. If this is so, then, the positive innovation effects of auctions can be questioned. However, this is purely an empirical question: which effects dominate, competitive pressures or the other mechanisms? And how do auctions behave in this regard with respect to alternative support instruments, whether quantity-based (quotas with renewable

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c For example, Hoppmann et al (2013, p.1000) argue that "deployment policies are effective instruments for inducing innovation as they trigger investments in exploration and provide firms pursuing more mature technologies with the possibility to benefit from exploitation".

energy certificates) or price-based ones (ASFITs/FIPs)? This paper tries to answer the following research questions: Do auctions promote innovation in RETs? Do they promote innovation more than other deployment-support instruments?

2. A short account of the research performed

This paper carries out an econometric analysis on the impact of auctions on innovative activities in solar PV using an unbalanced panel data set of 20 OECD countries with patent data and renewable energy auctions for the period 2000-2016. An econometric analysis with an estimation of a negative binomial model is performed. Data on patent applications is our dependent variable, whereas two categories of independent variables are included in the model specification: policy variables and control variables. Policy variables include three dummy variables for the demand-pull instruments and a continuous variable for the supply-push instrument (R&D support).

3. Main conclusions and policy implications of the work

Our results show that auctions have not had a statistically significant effect on PV innovation. Auctions do not show a significant influence on the realisation of innovative activities for solar PV technologies in any model specification. In contrast, administratively-set feed-in tariffs and renewable certificates have had a positive and significant impact on PV innovation. Thus, they support the hypotheses that the incentive to innovate in RETs provided by auctions is weak and that this incentive is lower than with alternative deployment support instruments and, particularly, ASFITs/FIPs.

These results have obvious policy implications. The innovation literature argues that policy-induced innovation requires a combination of supply-push and demand-pull instruments. However, if the demand-pull instrument is not present because the most widespread demand-pull instrument (auctions) is not effective in this regard, then innovation processes might suffer. Despite this, auctions may still have a valuable role to play in the energy transition. The potential negative innovation effects of auctions can be mitigated by combining them with other instruments and including appropriate design elements which encourage innovation.