Market and non-market policies for renewable energy diffusion: a unifying framework and empirical evidence from China's wind power sector

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Executive Summary

Increasing environmental and energy concerns can be addressed by accelerating technological change around the world. A technology can significantly impact an economy only if it is widely adopted by producers and accepted by consumers. The literature has identified two groups of driving forces behind technology diffusion: One includes market-based forces leading to pecuniary effects and the other includes non-market based forces leading to epidemic effects. In this study, we study the role of technology diffusion in the renewable energy development, particularly in the wind power sector in China. Although China had almost no wind power capacity in 2001, the country has led the global wind market with the highest installed capacity since 2010. This seemingly accessible wind technology did not diffuse to all countries. How could China have kept the technology diffusion so rapidly? What are the quantitative effects of various driving forces?

To answer these questions, we provide a comprehensive framework of analyzing the diffusion process of renewable technology, incorporating epidemic and pecuniary effects. With a panel data of China's CDM wind energy sector, we find strong evidence on the dominant role of the epidemic effect and new evidence on pecuniary effects that generate a diminishing marginal effect of profitability in inducing technology adoption. Our numerical simulation demonstrates that the epidemic effect can play a quantitatively important role in the spread of renewable energy technology and markedly enhance the optimal social welfare. Our findings convey important policy implications for regulators when choosing policy instruments to enhance the diffusion and adoption of clean technology. Price instruments should be complemented by a wide range of non-market instruments to address non-market barriers. Policy interventions should be taken using a systemic approach.

Our model can be generalized to any geographical context with rich renewable resources endowment, because we assume that relative to the early adoption, the market potential of renewable energy endowment is large enough to derive a reduced form of the empirical model. Thus, we do not need to compile a dataset on the complete life cycle of technology diffusion to undertake empirical research on the diffusion of new technologies.

We find that the epidemic effect may significantly influence the pattern of renewable technology diffusion. This implies that policy instruments can internalize positive (learning-by-doing) and negative (carbon emissions) externalities to obtain an overall effect on adoption that is greater than their direct effects, since the new adopters induce others to adopt as well. The cumulative impact of subsidies in forms of feed-in-tariff or carbon price will be significantly greater than their immediate impact. Thus, the optimal social welfare can be enhanced.

Our study suggests that the epidemic effect is not derived from the traditional market failure-based policy perspective. It may be largely reflected in the absorptive capacity, user-innovator interaction, and institutional cooperation. Understanding the sources of this epidemic effect may change the justification of choosing policy instruments. With a traditional market failure approach, policy intervention always aims to internalize externalities. However, with a systemic approach of policy interventions, such policies may have a set of different goals, such as facilitating the knowledge

creation and exchange, achieving institutional coordination not provided by the market, or increasing the cognitive capacity of firms. The policy makers need to strengthen this technology diffusion system together with existing subsidies.