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The policy effectiveness of economic instruments for the photovoltaic and wind power development in the European Union

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ABSTRACT

This paper measures the policy effectiveness of power purchasing agreements, capital grants, tax incentives, preferential loans, and research, development, and demonstrations for photovoltaic (PV) and wind power development in the member countries of the European Union (EU). The empirical findings confirm that the feed-in tariff is more efficient than renewable portfolio standards (RPS) for PV and wind power development, although RPS does have an effect on wind power development. However, the other economic instruments are all inefficient for PV development but are efficient for wind power development, except for tax incentives. Moreover, the economic growth required, serious financial deficits, and dependence on imported energy that discourage PV development are unrelated to wind power development. The energy intensity of the economy will have a negative impact on both PV and wind power development.

1. Introduction

Because they have low greenhouse-gas (GHG) emissions, renewable energy sources (RES-E) are useful in mitigating the damage caused by climate change, which is mainly caused by utilizing fossil energy. Governmental authorities formulate diverse policies, such as power purchase agreements (PPA) (in the form of feed-in tariffs or renewable portfolio standards), capital grants, tax incentives, preferential loans, and research, development, and demonstrations (RD&D) to introduce large-scale RES-E into power markets, even with the economic and technological barriers placed on RES-E.

The feed-in tariff (FIT) scheme involves an obligation on the part of electrical utilities to purchase the electricity produced by renewable energy producers in their service area at a tariff determined by the public authorities and guaranteed for a specified period of time. The renewable portfolio standards (RPS) scheme is one in which a fixed quota of electricity, sold by operators on the market, must be generated from RES-E. Certificates are issued by renewable electricity generators, who benefit from generating renewable electricity in two different ways: by selling it on the network at the market price, or by selling certificates on the green certificates market.

Capital grants provide a valuable subsidy by mitigating the financial burden of renewable energy, because the grants reduce the amount of value investors must put at risk; this situation increases their leverage, thereby enhancing returns. RD&D programs for renewable energy technology improvements typically employ a deterministic forecast regarding the cost and performance of RES-E. Tax incentives in the form of tax exemptions, tax deductions, and tax credits are used to reduce the cost of power generation from RES-E. Preferential loans (a type of low interest loan) can also be provided to renewable energy project developers to overcome high initial project costs.

The European Union (EU) is a full party of the United Nations Framework Convention on Climate Change (UNFCCC) and a signatory of the Kyoto Protocol, and it has accepted a quantitative absolute reduction target of 8% of its GHG emissions. The European Commission (EC) promulgated the Directive 2001/77/EC (which

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has since been replaced by Directive 2009/28/EC) to stipulate that 12%[1] of electricity must be produced from RES-E. This action initiated a debate in the EU regarding what type of PPA system should be established. A system of FIT consists of an obligation for utilities to purchase RES-E electricity at a set price. The tariff is based on the cost of electricity produced plus a reasonable profit for the producer. It aims to send a signal to potential investors to make long-term investments in new and innovative technologies and thus ultimately help drive down the costs of those technologies. Another system, RPS – possibly associated with tradable green certificates, also includes an obligation for utilities to purchase or self-generate RES-E electricity at or above a minimum quota. It is believed that competition among different technologies will drive down costs and thus encourage a more rapid spread of RES-E power generation.

While given the fact that individual RES-E possesses rather different nature, economic instruments designed by governments may not always function well in driving up the utilization of RES-E. However, the effectiveness of these instruments is constantly in debate or these instruments are analyzed and discussed in aggregate not separately, which leads to some policy makers having difficulty in adopting appropriate measures to promote further growth of RES-E. Therefore it prompts the present paper to extend discussions of policy effectiveness of the PPA, capital grants, RD&D, tax incentives, and preferential loans for RES-E development, especially for the most mentioned photovoltaics and wind power. In addition, the data used in many studies need be updated to grasp the recent trends of government policy and RES-E development which may lead to a new understanding of the effectiveness of these policies. Thus this paper uses a panel data set encompassing 21 member countries of the EU between 1996 and 2013 to carry out the analyses. The empirical results can help governments formulate more efficient policies and incentive schemes for PV and wind power promotion.

The remainder of this paper is organized as follows: Session 2 delivers a literature review focusing on policy instruments for the development of RES-E; Section 3 presents the panel regression models; Section 4 provides the sources of the data and summary statistics; Section 5 details a discussion of the empirical findings; and finally, Section 6 offers conclusions.

2. Literature review

The price-based and quantity-based approaches are regarded as comparable methods for achieving technical change and RES-E targets. The RPS scheme is more effective in controlling the cost of government incentive policies because, by inviting tenders for successive quotas, it is possible to maintain direct control over installed capacities and indirect control over the marginal production cost and thus over the cost for the community. Similar control is also maintained through the quotas imposed on electricity suppliers under green certificate schemes. Conversely, in the FIT scheme, RES-E production cannot be anticipated with any precision because of the uncertainty regarding cost curves. Although it is theoretically possible to adjust prices according to the response of producers, in practice, this type of control would be difficult to implement for political and institutional reasons. This situation would make it difficult to adjust quantities and thereby control the cost for the community. In terms of installed capacity, the FIT system has yielded far better results than the RPS system [1]. Other studies also argue that a quantity-based approach is superior to a price-based approach in promoting technological change [2–4].

However, FIT encourages technological learning. Engineers are persuaded to produce more efficient technologies to increase the amount of electricity generated and the rate of profit return from the initial investment. In a well-structured FIT system, various technologies of different scales and stages of development are eligible for tailored incentives. This situation encourages the development of renewable energy being more economically efficient in many locations and circumstances [5]. The results from one study, which compares FIT and RPS schemes from market-based deployment of renewable energy in the United Kingdom and Germany, show that FIT reduces costs to consumers and results in larger deployment [6]. Another study has similar finding for European countries, though FIT is aggregated into “Incentives/Subsidies” and RPS is treated as one of “Regulatory Instruments” [7].

In RPS schemes, a target for RES-E penetration is set by public authorities seeking to minimize cost for achieving this target. The certificate price is set by the market. In a FIT system, public authorities set an effective price but do not limit the quantity installed. This has led to impressive growth rates. It is found that investor risks are much lower in a FIT system, and that innovation incentives are larger. Given the underlying objective of addressing security, and the EC proposal's continued reliance on national systems, FIT would be preferred [8].

RPS with cost-based FIT also disregards economic efficiency because FIT that are determined through a cost-plus approach under a rate of return framework lack incentives for cost minimization and discourage optimal utilization of RES-E [9,10]. In fact, the FIT and RPS systems serve different purposes and cannot be measured against a common efficiency standard. Because RPS schemes attempt to achieve a set percentage of RES-E consumption at the lowest cost, they tend to restrict geographical distribution, limit technological diversity, contribute little to the early phases of RES-E technology development, and often lead to a reliance on foreign equipment producers. FIT schemes promote RES-E technology development and equipment industries even at early stages and across a broad technological and geographical spectrum [11]. If the markets were perfectly competitive, the two policies would achieve the same efficiencies. When the markets are imperfect, the supplies of renewable energy under FIT are higher than those under RPS. However, social welfare under RPS is consistently higher than under FIT for a wide range of values of the parameters [12]. In contrast to the EU approach to reducing carbon dioxide emissions, its RES-E program is almost certain not to minimize the cost of achieving its goals. RPS programs in the United States are also almost certain to cost more than necessary. Despite the greater popularity of FIT schemes worldwide, RPS programs may involve less social risks in the long-term [13].

Some research empirically supports existing case studies that show a positive relationship between RPS and wind power development. Wind producers experience less risk through FIT than through RPS in terms of price and volume [14,15]. The FIT is also a better mechanism than RPS for increasing the profitability of solar PV systems and wind energy projects [16], though some study finds that FIT is less capable in driving the development of wind power except combined with a tendering scheme [17]. However, at least one study, using panel data, found no significant difference between FIT and RPS in promoting wind capacity growth [18]. This result is also implied by another study that finds “market deployment policies” is the driver for the development of RES-E [19].

[1] In March 2010, EU leaders unveiled the Europe 2020 strategy for smart, sustainable, and inclusive growth. It includes three targets relating to the environment and climate change: (1) greenhouse gas emissions 20% lower than 1990; (2) 20% of energy from renewables; (3) a 20% increase in energy efficiency. The flagship initiative for a resource-efficient Europe under the Europe 2020 strategy supports the shift towards a resource-efficient, low-carbon economy to achieve sustainable growth.