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Prices versus quantities: Comparing economic efficiency of feed-in tariff and renewable portfolio standard in promoting renewable electricity generation

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ABSTRACT

In order to promote renewable electricity generation, several countries have been adopting a feed-in tariff (FIT) or a renewable portfolio standard (RPS). Of these two renewable energy policies, investigating which one has better performance is a subject of debate. This study comparatively analyzes the economic efficiency of FIT and RPS in the South Korean renewable energy market. FIT was implemented from 2002 to 2011, while RPS has been in force since 2012; hence, a comparative analysis of the two policies is ideal. The benefit cost ratio and net present value were measured from two different perspectives: the government and energy producers. The results showed that RPS was more efficient for photovoltaic energy from the government's perspective, whereas FIT, for non-photovoltaic energy, such as wind power, bio-energy, and fuel cells. However, from the energy producers' perspective, FIT was more efficient for photovoltaic energy, while RPS was more efficient for non-photovoltaic energy.

1. Introduction

Renewable energy has many environmental and safety advantages compared to conventional energy sources. To address climate change, decrease fuel import dependency, diversify energy sources to respond to external changes and shocks, and dominate future technology markets, many countries have been developing their renewable energy supplies (Lee and Huh, 2017). Thus, renewables have now been globally established as mainstream sources of energy, providing an estimated 19.2% of global final energy consumption as of 2014 (REN21, 2016). Since combatting global climate change predominantly includes strategies involving renewable energy implementation, its supply is expected to grow steadily in the future.

National- and state-level policies play critical roles in the effective promotion and dissemination of renewable energy because of its cost disadvantage compared to conventional energy sources. Extant literature already highlights the importance of government intervention, with adequate policy, in the expansion of renewable energy supply and related technological innovations (Dulal et al., 2013; Kim and Kim, 2015; White et al., 2013; Rao and Kishore, 2009; Tan et al., 2008). For example, Zyadin et al. (2014) confirmed that the lack of governmental policies was a critically limiting factor for renewable energy development worldwide. Therefore, recently, a majority of the countries have renewable energy support policies in place (REN21, 2016), while policymakers have developed various policy mechanisms to promote renewable energy worldwide. These policies can be categorized into fiscal and financial incentives, market-based instruments, option to provide funds, policy instruments related to investment decisions, and regulatory measures (Polzin et al., 2015).

Renewable energy is used in three sectors: electricity, heating and cooling, and transport. Despite the growing interest in transport and heating and cooling, the electricity sector still performs the most crucial role in expanding the supply of renewable energy, with relatively active implementation of related policies (Huh et al., 2014). The core policy decision in the renewable energy sector is to choose between price- or quantity-based policies for adoption as the main scheme. The former is represented by feed-in tariffs (FIT) and the latter, by renewable portfolio standard (RPS)—the two main support mechanisms for renewable electricity development (Lipp, 2007). Since most countries predominantly implement the aforementioned policies over other options, we may conclude that they currently play a key role in the renewable electricity sector. Moreover, a similar number of countries implement either the FIT or RPS policy; hence, it is difficult to ascertain which one of the two policies is evidently superior.[1] In fact, for many countries, choosing

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[1] The number of states, provinces, and countries with FIT policies is 110, while the number of those with RPS/quota policies is 100 (REN21, 2016).

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either policy is a crucial, but difficult, policy decision; thus, both are implemented as per the circumstances, or countries switch between policies at certain points. Therefore, it is important to determine the advantages and disadvantages of FIT and RPS, and to evaluate their relative performance. Many studies have investigated such policy impacts, but presented differing results depending on individual focus (de Mello Santana, 2016; Dong, 2012; Sun and Nie, 2015).

This study compares the economic efficiency of FIT and RPS by conducting cost-benefit analysis (CBA) and calculating net present value (NPV), based on which it provides implications for effective supply of renewable energy. The subject of empirical analysis is South Korea, which is highly suitable for analysis, since it has implemented both policies within the electricity sector.[2] Currently, with the implementation and establishment of RPS in Korea, an empirical comparison of FIT (which had been already implemented) and RPS can provide both policy implications for institutional operations of FIT or RPS in other countries and improvement of the domestic RPS scheme.

The novelty and contribution of this study are as follows. First, this study explores, in detail, which policy—FIT or RPS—is relatively more efficient for each renewable energy source in the economic view. Second, by drawing the costs and benefits of the policies in the government and energy producers' perspectives, it suggests implementable, specific actions for individual players. In addition, this study can be used as a reference for related research by systematically presenting detailed items to estimate the costs and benefits of FIT and RPS.

This remaining study is presented as follows. Section 2 summarizes previous studies covering FIT and RPS policy effects or using CBA in the renewable energy sector, and presents the marginal contribution of this study. Section 3 provides a detailed description of the research methodologies—CBA and NPV. It also presents detailed items to estimate the costs and benefits of the two policies in the process. Section 4 includes the results of the empirical analysis. It provides the results according to the scenario setting, based on which it compares the economic efficiency of the two policies for each source. Finally, Section 5 summarizes the study results and limitations, and sets the direction for follow-up research.

2. Literature review

2.1. Debates on the policy impacts of FIT and RPS

FIT is a "pricing policy" that covers the difference when the market price of renewable electricity is lower than the reference price that reflects the standard cost by each renewable source. On the other hand, RPS is a "quota system" that makes it mandatory for energy suppliers to produce a certain ratio of supplied power from renewable sources.[3] Two frequently used evaluation criteria for renewable support schemes are their effectiveness and economic efficiency (Ragwitz and Steinhilber, 2014). In order to better understand the aim of this study, it is necessary to distinguish between effectiveness and economic efficiency of a renewable policy. First, in terms of renewable policy, effectiveness refers to the extent to which a promotion strategy is capable of triggering renewable deployment, which is either measured in increased generation or increased installed capacity (Ragwitz and Steinhilber, 2014). On the other hand, efficiency or economic efficiency of a policy has more varied definitions in extant literature. Considering all these studies, the major difference between efficiency and effectiveness is whether its criterion considers required costs or additional impacts of policy enforcement or not.[4] For example, Gunn (1997) pointed out that economic efficiency is often defined as comprising the minimization of the cost of operations and the optimization of investment decisions. Since this study considers both benefit and cost factors of FIT and RPS by using CBA and NPV, it analyzes the two policy alternatives with a focus on economic efficiency.

With such clear differences in the operation methods, advantages, and disadvantages of the two policies, there have been constant researches on the comparison of the two policies. Some of the earlier studies include Lauber (2004) and Lipp (2007). This section reviews previous literatures that compared the policy impacts of FIT and RPS in different perspectives, and summarizes the limitations and implications of this study. First, major studies that proved FIT's superiority over RPS are examined. Butler and Neuhoff (2008) compared the two policies by comparing the price and deployment level of wind power in England and Germany, which adopted RPS and FIT. The results suggested that the cost of the FIT is lower than that of the RPS. The long-term price guarantee provided by FIT reduces regulatory and market risk, and explains the lower cost. Based on interviews from 43 institutions in Southeast Asia, Sovacool (2010) evaluated eight renewable electricity policy mechanisms with five indicators, followed by a comparative analysis. FIT was found to be the only mechanism that met all criteria. Haas et al. (2011a, 2011b) reviewed promotions strategies of renewable energy sources within the European electricity market, and depicted their properties. Results showed that FIT provided a certain deployment of renewable electricity in the shortest time and at the lowest costs for society, while RPS showed a relatively lower effectiveness. Dong (2012) investigated the relative effectiveness of FIT and RPS for wind capacity development by analyzing five years of panel data in 53 countries. The study claimed that FIT performed better than RPS. It concluded that FIT had better long-term effects in promoting wind energy, although, in the short run, RPS could also provide some incentives to developers. Kilinc-Ata (2016) analyzed which policy is more effective for renewable electricity deployment using panel data of 27 EU countries and 50 US states from 1990 to 2008, as well as the fixed-effect regression model. The result showed that FIT was an effective mechanism for stimulating deployment capacity of renewable electricity, while quota (RPS) was not. Using a panel regression model, recently, Li et al. (2017) measured the effectiveness of diverse policies for the photovoltaic (PV) and wind power development in the EU. The findings confirmed that the FIT is more efficient than RPS for PV and wind power development.

Meanwhile, there are studies that claim RPS's superiority over FIT. Schmalensee (2012) pointed out that the previous studies claiming FIT's superiority neglected its impact on actors other than investors in renewable energy sector and those who pay subsidies. The theoretical model presented by the author showed that, as long as the unit cost of renewables was higher than the unit cost of fossil electricity, RPS involved less long-run social risk than FIT. de Mello Santana (2016) analyzed the long- and short-term cost-effectiveness of RPS, FIT, and auctions using levelized lifecycle costs and experience curves. Results showed that RPS was more cost-effective than FIT in the short-term from the consumer perspective.

Certain analysis results also claim that FIT and RPS have different parts that are relatively more effective depending on the detailed policy effect or evaluation criteria even within the same study. For example, focusing on comparing price-based approaches with quantity-based ones, Menanteau et al. (2003) examined the efficiency of different incentive schemes for the development of renewable energy sources. They concluded that the quantity-based approach was more effective in controlling the cost of government incentive policies, while price-based approaches gave significantly better results in terms of installed capacity. Sun and Nie (2015) compared different effects of FIT and RPS using a game theory model. The results showed that FIT had relative strengths in installed capacity increase and R&D input stimulation, while RPS was relatively strong in reducing carbon emissions and increasing consumer surplus. Ritzenhofen et al. (2016) quantitatively compared different renewable policy instruments, including FIT and

[2] South Korea had implemented FIT from 2001 to 2011, and has been implementing RPS since 2012 (Huh et al., 2015).

[3] See Lipp (2007) for details on the concept of FIT and RPS, operation methods, and major advantages and disadvantages.

[4] The concept and practice of economic efficiency and effectiveness of policy instruments can be found in Gunn (1997), Perrels (2001), and Ragwitz and Steinhilber (2014) in more detail.