Incorporating Aversion To Market Price Risk In Efficient Feed-In Tariff Specification

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Overview

Publicly-funded support mechanisms are required for renewable energy investments to be viable. (IEA, 2008, 2012; Del Rio and Bleda, 2012). Governments are faced with the problem of identifying means to stimulate deployment in the most cost-effective and efficient way (IEA, 2008). Investment in renewable technologies is subject to uncertainties surrounding potential revenue and thus incorporating agent reactions to uncertainty and risk has been deemed important in specifying appropriate policies of financial support (Masini and Menichetti, 2012; Wüstenhagen and Menichetti, 2012).

Feed-in Tariffs (FiT) offer a price guarantee and have been found to limit investors' exposure to market price risk to a greater extent than alternate mechanisms, becoming the preferred policy option in many jurisdictions (IEA, 2008, 2012; Ragwitz, 2007; Bürer and Wüstenhagen, 2009). However, protecting investors from potentially low market prices requires this risk to be borne by those funding the policy measure. This burden often rests with electricity consumers.

In many jurisdictions, relatively high FiT rates and lower than expected fossil fuel prices may result in a greater than expected consumer burden (Devitt and Malaguzzi Valeri, 2011). This burden is regressive in nature (Farrell and Lyons, 2014) and may have a negative impact on economic growth. Consumers' exposure to market price risk has not featured strongly in FiT design decisions to date. However, increasing penetration coupled with the increasing proliferation of low-cost unconventional gas make any potentially incurred price risk of greater importance as renewables targets are fulfilled.

As Farrell et al. (2013), Couture and Gagnon (2010) and Kim and Lee (2012) have outlined, FiTs may take a number of forms. A Fi T may be a fixed price, a price floor where investors receive all or a share of market upside, or a cap and floor policy. Each FiT design allocates the market price risk between consumers and investors in different ways (Farrell et al., 2013).Thus, an optimal FiT design may be chosen that efficiently allocates this exposure to market price risk, conditional on the exposure each party is willing to incur, alongside the expected market conditions. Indeed, the literature to date has been unable to determine why one tariff choice may be preferred over another (Saidur et al. 2010), with this paper thus developing an economic rationale for FiT choice through the efficient allocation of risk exposure.

Methods

The interaction between the policymaker and renewable energy is treated as a Stackelberg leader problem. The policymaker is the 'leader' in this case, with the follower being the entire renewable energy industry. The policymaker's objective is to set a FiT price that incentivises the deployment of a certain quantity of renewable capacity. The policymaker anticipates the investor's profit maximising deployment response for each price chosen. The problem is solved when a price is set such that the investor responds by deploying the desired quantity of renewable capacity. This procedure is repeated to identify an efficient FiT price for a number of different price support designs. Uncertainty is incorporated into the model by assuming standard stochastic price processes and employing option pricing theory. Investor and policymaker/consumer risk aversion is introduced into this theoretical framework, such that the efficient allocation of market price risk may be identified through appropriate FiT design. Risk aversion is modelled using a Constant Relative Risk Aversion (CRRA) utility specification, calibrated to degrees of risk aversion observed in the literature. Alternative levels of risk aversion are captured through a wide spectrum of risk aversion parameters and sensitivity analyses.

Efficient FiT rates and market price exposures are solved under a range of scenarios. These scenarios account for a range of investor/policymaker preferences, market price conditions and policymaker goals.

Results

Investor preferences are more influential than those of the policymaker when degrees of risk aversion are of a similar magnitude. Under our baseline assumptions, market price risk should be shared except under circumstances of extreme investor/consumer indifference to risk. This suggests that commonly employed fixed price and constant premium policies are sub-optimal unless investors or consumers are risk neutral. We find that cap & floor policies are a preferential way to share market price risk than shared upside policies. This is because the different pattern of risk sharing requires a slightly lower minimum price guarantee under a cap & floor regime. This impact is emphasised when efficient prices are lower, an occurrence which is more likely to prevail when policymakers are extremely risk averse and investors are modestly risk averse. In Expected Money Value (EMV) terms, constant premium policies are always more expensive than those that share market upside, but are optimal when policymakers are extremely risk averse and investors have low levels of risk aversion.

Efficient division of market price risk is of increasing importance as policymakers and investors are more sensitive to market price risk, with policymaker sensitivity of greater influence. Such sensitivity may change as renewables deployment grows and becomes a larger share of total electricity cost. For many risk aversion scenarios, the optimal division of market price risk transitions through a wide spectrum of possible levels as such sensitivity changes. This has implications for both current and future policymaking. First, this suggests that consideration of optimal market price risk is of increasing importance as renewables deployment grows. Second, current policy should anticipate such a potential requirement and put in place flexible legislative measures to accommodate market price risk division if required.The impact of FiT specification on investor and policymaker utility is also identified, where investor utility is found to be invariant to FiT choice and assumptions surrounding risk aversion, whilst policymaker utility is considerably sensitive. Finally, a sensitivity analysis repeats these simulations for different market price scenarios, renewables targets and utility/risk aversion specifications.

Conclusions

The literature to date has suggested that FiT specification is based on non-economic factors such as local circumstance and ideological approach (Saidur et al., 2010). This paper allows for economic considerations to be incorporated in future policymaking by developing an economic framework to specify an efficient Feed-in Tariff (FiT) design. An economic rationale for the optimal specification of a number of tariff designs is offered, with which a policymaker may make a more informed decision as to both the level and format of a chosen FiT. Numerical simulations show how FiT structure may be designed to given an optimal delineation of market price risk between investors and policymakers.

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