The Electricity Journal 29 (2016) 1–6

Contents lists available at ScienceDirect

The Electricity Journal

journal homepage: www.elsevier.com/locate/electr

Cost reduction incentives in electricity markets with overlapping regulations

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ARTICLE INFO

Article history:
Received 18 October 2015
Accepted 30 January 2016
Available online xxx

JEL classification:
Q48
Q58
H23

Keywords:
Overlapping regulations
Renewable energy
Feed-in tariff
Cost reduction incentives
Cost padding

ABSTRACT

Recent research has documented some potential unintended consequences of so called "overlapping regulations" in electricity markets. A primary example of these overlapping regulations are the emissions trading scheme and the various renewable energy (RE) support mechanisms currently employed in the EU to enforce a "green quota". One common RE support mechanism is a system of premium feed-in tariffs. Under such a system, RE producers receive subsidies that are typically "generation cost based" but there is an expectation that as technological improvements in the RE production chain reduce costs, the subsidies will be eliminated as RE installations become competitive with fossil fuel producers. Therefore, one important component of the study of overlapping regulations is the analysis of the cost reduction incentives facing RE producers. To this end, we employ an example based on a stylized partial equilibrium model of a closed, competitive electricity market operated under both an emissions trading scheme and a green quota implemented via a system of premium feed-in tariffs. We demonstrate that there will always be one RE producer that has an incentive to both pad its own costs and attempt to disadvantage its rivals by increasing their costs. Moreover, we show that the total RE resource cost of meeting the emissions target and green quota are unaffected by cost reductions by RE producers. However, cost reduction incentives can be restored if the subsidies remain fixed for a "reasonable" period of time and the green quota is eliminated.

1. Introduction

Around the world, climate change concerns have led to ambitious policies designed to reduce carbon emissions and promote the development and deployment of renewable energy (RE), i.e., "green" resources. One important example is the EU's recently implemented 2030 Framework for Climate and Energy Policy. This initiative calls for a 40% reduction in carbon emissions (relative to 1990 levels) and an increase in the share of green energy (a "green quota") to at least 27% by the year 2030 (European Commission, 2014). Thus, in addition to the emissions trading system introduced in 2005, a variety of related policy instruments are being employed in the EU to promote RE development.

These types of so called "overlapping regulations" have been analyzed, beginning with Tinbergen (1952) and include more recently del Río Gonzalez (2007), Fischer and Preonas (2010), and OECD (2011). In general, the central principle that emerges from this research is that if the sole policy objective is to correct a single specific market failure, the introduction of two or more independent policy instruments will either be redundant or increase policy costs unnecessarily. Thus, the introduction of an additional policy instrument requires the demonstration of the existence of an additional market failure. Some researchers (e.g., Lehmann, 2013) point to the presence of learning externalities in RE as the justification for the use of an additional policy instrument.

Several recent studies have documented some unintended consequences of overlapping regulations in energy markets. In a partial equilibrium context, Böhringer et al. (2008) show that there are excess costs from the simultaneous use of emissions taxes and emissions trading in the EU. Böhringer and Rosendahl (2010) demonstrate that imposing (or strengthening) a "green quota" in the presence of an emissions trading scheme will increase the production level of the most emissions-intensive producer. Using a two-sector general equilibrium model, Eichner and Pethig (2010) study the distributional aspects of combining the EU-type emissions trading scheme with emissions taxes and conclude that the emissions taxes should be discontinued. Currier (2014) shows that the simultaneous use of green certificate systems and investment cost reduction policies in RE markets will lead to increased emissions by fossil fuel based (i.e.,"black energy")

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http://dx.doi.org/10.1016/j.tej.2016.01.009
1040-6190/

producers. In addition, Böhringer and Behrens (2015) provide a comprehensive analysis of the manner in which an emissions trading scheme and various RE promotion policies interact.

This paper is a contribution to the literature on the unintended consequences of overlapping emissions regulation and RE support policies in energy markets. One common support mechanism for RE is a system of premium feed-in tariffs. Under such a system, grid operators are required to take in electricity generated by "green energy" producers. These producers are then compensated for higher generation costs via a subsidy for each unit of electricity generated. These subsidies are paid in the form of a premium added to the market price of the electricity. There is however a presumption that green producers will eventually become competitive with black producers due to technological improvements/cost reductions in the RE production chain, at which time the subsidies will be eliminated. (Couture and Gagnon, 2010). Therefore, one important component of the study of overlapping regulations is the analysis of cost reduction incentives on the part of green producers. To gain insights, we employ an example based on a stylized partial equilibrium model of a closed, competitive electricity market operated under both an emissions trading scheme and a green quota implemented via a system of premium feed-in tariffs. Our analysis demonstrates that there will always be one green producer that has an incentive to both pad its own costs and attempt to disadvantage its rivals by increasing their costs. Moreover, we show that the total RE resource cost of meeting the emissions target and green quota are unaffected by cost reductions by green producers. However, cost reduction incentives can be restored if the subsidies remain fixed for a "reasonable" period of time and the green quota is eliminated.

2. Description of the electricity market

We consider a competitive electricity market where electricity is generated by both fossil fuel based producers ("black" producers) and renewable producers ("green" producers). Emissions from black producers are assumed proportional to output. Green producer costs are conditional on a cost parameter c_j that reflects the green generation technology as well as manufacturing and installation costs of equipment used as inputs in the generation process by green producer *j*. Green producers generate zero emissions. All producers are assumed to maximize profit.

We assume that the policy maker market has imposed a binding emissions cap implemented via an emissions trading system. In addition, we assume that the policy maker has imposed a binding "green quota", where a specified share of total electricity generation is required to originate from green producers. We assume that the green quota is implemented via a system of differentiated feed-in tariffs (i.e., technology-specific production subsidies to green producers), financed by an end-user tax on electricity. Market equilibrium is formally described by Eqs. (1)–(7) in the Appendix A (Part 1) where it is assumed that there are *n*-black producers and *m*-green producers.

With the emissions cap and the green quota both binding, the equilibrium solutions to the model are determined by the green producers' cost parameters. It is straight forward to show that in general, the effect of a reduction in the cost parameter of green producer *j* on green producer *j*'s profit is indeterminant.

3. Equilibrium analysis

To gain insights into the equilibrium impacts of green producers' cost parameter changes under overlapping regulations, we consider an example with two black producers and two green producers. A full description of the assumed demand and cost information etc. is presented in the Appendix A (Part 2). We assume throughout that the most emissions intensive black producer has the lowest production cost. The overlapping regulations involve a binding emissions cap of 80 and a binding green quota of 20%.

Using Eqs. (1)–(7), for an arbitrary combination of the green producers' cost parameters, there exists two distinct equilibria that we denote by E1 and E2 and report in the Appendix A (Part 3) where σ denotes the equilibrium emissions price, s_1 and s_2 denote the equilibrium subsidies and π_j and C_{jx} denote green producer equilibrium profits and costs, respectively, $j = 1, 2$.

Observe first that in each equilibrium, the electricity price, black producer outputs, the emissions price, total green output, total green producer costs and total green producer profits are independent of the values of these cost parameters. This implies then that equilibrium price and quantity in the electricity market depends only on the tax rate, the level of the emissions cap, and the level of the green quota. In our setting the *market equilibrium price and quantity* is uniquely determined by the end user tax rate, the level of the emissions cap and the value of the green quota but there are two output/subsidy scenarios in the green sector that support it.

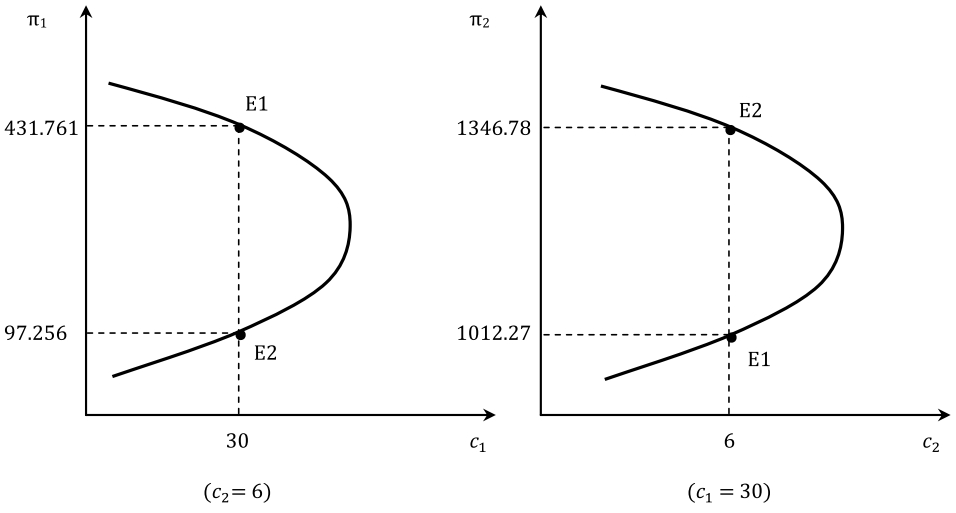

Fig. 1. Own effects of cost reductions.