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Redistribution effects of energy and climate policy: The electricity market[☆]

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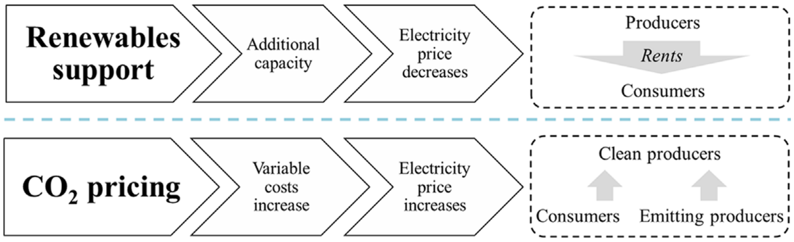
HIGHLIGHTS

- CO_2 pricing and renewables support have strikingly different impacts on rents.
- Carbon pricing increases producer surplus and decreases consumer surplus.
- Renewable support schemes (portfolio standards, feed-in tariffs) do the opposite.
- We model these impacts theoretically and quantify them for Europe.
- Redistribution of wealth is found to be significant in size.

GRAPHICAL ABSTRACT



Renewable support redistributes economic surplus from incumbent producers to consumers.
CO_2 pricing does the opposite, but affects carbon-intensive and low-carbon technologies differently.

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ABSTRACT

Energy and climate policies are usually seen as measures to internalize externalities. However, as a side effect, the introduction of these policies redistributes wealth between consumers and producers, and within these groups. While redistribution is seldom the focus of the academic literature in energy economics, it plays a central role in public debates and policy decisions. This paper compares the distributional effects of two major electricity policies: support schemes for renewable energy sources, and CO_2 pricing. We find that the redistribution effects of both policies are large, and they work in opposed directions. While renewables support transfers wealth from producers to consumers, carbon pricing does the opposite. More specifically, we show that moderate amounts of wind subsidies can increase consumer surplus, even if consumers bear the subsidy costs. CO_2 pricing, in contrast, increases aggregated producer surplus, even without free allocation of emission allowances; however, not all types of producers benefit. These findings are derived from an analytical model of electricity markets, and a calibrated numerical model of Northwestern Europe. Our findings imply that if policy makers want to avoid large redistribution they might prefer a mix of policies, even if CO_2 pricing alone is the first-best climate policy in terms of allocative efficiency.

1. Introduction

Two of the major new policies that have been implemented in European, American, and other power markets during the last years are support for renewable energy generators and CO_2 pricing. Many countries have introduced support schemes for renewable electricity, such as feed-in-tariffs or renewable portfolio standards. As a consequence, the share of renewables in electricity generation has been growing rapidly (REN21, 2013; OECD/IEA,

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2013). In the European Union, it increased from 13% in 1997 to 17% in 2008, in Germany, from 4% to 23% within the last two decades. According to official targets, the share of renewables in EU electricity consumption shall reach 60–80% by 2050. The second major policy was the introduction of a price for CO_2. In Europe CO_2 pricing was implemented via an emission trading scheme in 2005, and several countries, regions, and states have followed. During the last 8 years, the European carbon price has fluctuated between zero and 30 €/t, with official expectations of prices between 100 €/t and 300 €/t by 2050.[1]

These new policies affect the profits of previously-existing (incumbent) electricity generators. More general, they redistribute economic surplus between producers and consumers and between different types of producers and consumers. Support policies bring renewable capacity in the market that decreases the wholesale electricity price below the level it would have been otherwise. For example, wind power has low variable costs and reduces the wholesale electricity price whenever it is windy. Lower electricity prices reduce the profits of existing generators and increase consumer surplus. If subsidy costs are passed on to consumers, the net effect on consumer surplus is ambiguous a priori.

CO_2 pricing increases the variable costs of carbon-emitting plants. Whenever such generators are price-setting, CO_2 pricing increases the electricity price. Low-carbon plants like nuclear and hydro power benefit from higher prices without having to pay for emission. Carbon-intensive generators like lignite, in contrast, see their profits reduced because costs increase more than revenues. Consumer surplus is reduced due to higher electricity prices, and increased if they receive the income from CO_2 revenues. Again the net effect on consumers is ambiguous.

Policy can impact producer rents only in the short term. In the long-term equilibrium, assuming perfect and complete markets, profits are always zero. Only if a market features some sort of inertia, and newly introduced policies are not fully anticipated, the policy impacts profits. We believe power markets to fulfill these two conditions.

In this paper, we model and quantify the redistribution effects of renewable support policies and CO_2 pricing, using an analytical (theoretical) and the numerical (empirical) model EMMA. We distinguish two sectors: incumbent generators with sunk investments, and electricity consumers. State revenues and expenditures are assumed to be passed on to consumers as lump-sum payments. Generators are further distinguished by technology, since the effect of CO_2 pricing on generators depends on their carbon intensity and the effect of renewable subsidies depends on their capital intensity. Disaggregating consumers could yield important insights, but is beyond the scope of this paper (see for example Neuhoff et al., 2013). Markets are assumed to be competitive, thus profits are zero in the long term. The modeling approach is valid for different types of CO_2 pricing (emission trading, carbon tax) and different types of renewables support (feed-in tariffs, renewable portfolio standards with or without certificate trading, investment grants, tax credits) and is in this sense very general. We use wind power as an example for a subsidized renewable electricity source, but all arguments apply to solar power and other zero marginal-cost technologies as well.

In our quantitative assessment of Northwestern Europe we find that the redistribution effects of both policies are large. Overall, wind support distributes surplus from producers to consumers and carbon pricing does the opposite. Wind support transfers enough producer rents to consumers to make those better off even if they pay the costs of subsidies. Wind support reduces the profits of base load generators more than those of peak load generators. CO_2 pricing reduces the profits of coal-fired generators, leaves those of gas plants largely unaffected, and increasing the rents of nuclear plants dramatically. As a group, electricity generators benefit from carbon pricing even without free allocation of emission permits.

We acknowledge that power markets feature a number of externalities that we ignore in this study. While CO_2 pricing has the clear objective of internalizing the costs of climate change, policy makers have put forward a multitude of motivations for renewable support. This paper does not assess these motivations, does not take into account externalities, and does not provide a cost–benefit analysis of these two policies or evaluates them against each other. Rather, our goal is merely to point out their peculiar effects regarding the redistribution of wealth. We focus here on the impact of two policies separately, and the joint impact. Interactions with existing or new policies, such as energy efficiency, are beyond the scope of this paper.

The next section reviews the literature. Section 3 presents the analytical framework and introduces the models. Section 4 discusses the effects of wind support, Section 5 those of carbon pricing, and Section 6 the compound effects of both policies. Section 7 concludes.

2. Literature review

Redistributive impacts of climate and energy policy have become a major topic in economics research during the last years. Redistributive flows between jurisdiction, between generations, and between resource owners vs. resource consumers have received much attention; see for example Bauer et al. (submitted for publication) on resource owners. Edenhofer et al. (2013) provides a broader survey of the issue. This paper adds to this literature by analyzing redistribution between firms and consumers via the electricity market.

Focusing on the narrower field of electricity policies, the present paper builds on three branches of the literature on implications of policy instruments: the “merit-order” literature, the “windfall profit” literature, and the “policy interaction” literature. The first branch focuses on the depressing effect of renewables generation on the electricity price, which has been termed “merit-order effect”. The second branch discusses the impact of carbon pricing on consumer and producer surplus, where increasing producer rents are sometimes labeled “windfall profits”. The third branch discusses the interaction between these two policies.

Attracting additional investments in (renewable) generation capacity depresses the electricity price below the level it would have been otherwise. Because the size of the drop depends on the shape of the merit-order curve, Sensfuß (2007) has termed this the “merit-order effect”. A number of papers model the price impact theoretically and numerically. Modeling exercises for the Nordic countries (Unger and Ahlgren, 2005), Germany (Sensfuß et al., 2008) and Spain (De Miera et al., 2008) indicate that the additional supply of electricity from wind power reduces the spot price so much that consumers are better off even if they have to bear the subsidy costs. Results for Denmark are less conclusive (Munksgaard and Morthorst, 2008). Based on a theoretical model, Fischer (2010) finds that the sign of the price impact depends on the relative elasticity of supply of fossil and renewable generation. MacCormack et al. (2010) find the merit-order effect to be larger when conventional generators have more market power because both the additional supply and the uncertainty introduced by wind power reduce the incentive to withhold capacity. While these studies apply numerical models, O′Mahoney and Denny (2011)

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[1] 2050 targets are taken from the Energy Roadmap 2050 (European Commission, 2011).