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Cross-border effects of capacity mechanisms: Do uncoordinated market design changes contradict the goals of the European market integration?☆

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ABSTRACT

This paper analyses cross-border effects of a strategic reserve (SR) and reliability options (ROs) based on a two-country simulation model. Using a game-theoretic approach, the countries' policy options for capacity remuneration mechanisms (CRMs) are analysed with respect to welfare and distribution effects. An SR tends to narrow down the market, while ROs intensify price competition. However, cross-border effects are most likely negative for consumers and producers in total in the case of a unilateral implementation of a CRM, and market design changes should be coordinated.

All results are strongly driven by possible changes in competition and market power. In practice, the market design decision should also consider possible regulatory failures that might lead to further market distortions. The risk of market design flaws seems larger for full capacity markets such as ROs than for an SR, which requires only minor adjustments to the market design.

1. Introduction

Europe's electricity markets are heading towards high penetration of renewable energy sources (RES). The challenges of integrating intermittent and capital intensive RES into existing markets has led many European countries to reconsider their market design in favour of capacity remuneration mechanisms (CRMs). The reason is the "missing money problem" (Cramton et al., 2006): as a result of their low marginal cost, RES suppress electricity wholesale prices and reduce the prospects of conventional generation (as well as for storage and demand response) to earn sufficient revenues from electricity sales to the market. Those capacities are needed, however, to compensate for occasional shortfalls of RES supply. The idea of CRMs is to ensure generation adequacy by providing investment incentives through capacity-based payments to conventional generators that would otherwise suffer from both lower energy prices and a decreasing utilization of capacity in RES-dominated electricity markets.

The effectiveness and efficiency of CRMs have been broadly analysed, and different forms are applied around the world. Many EU member states currently consider redesigning their electricity markets in favour of a CRM or have already done so (CREG, 2012). However, there is still a lack of understanding, whether and to what extent CRMs may cause cross-border effects and thereby conflict with the European goals of an Internal Market for Electricity. This paper picks up the discussion and analyses the cross-border effects against the background of European market integration based on a theoretical simulation model.

The Internal European Energy Market is a key part of the EU 2020 strategy, as it is considered an important tool to ensure affordable, secure and sustainable electricity supply in the future (European Commission, 2010). It aims to enhance competition by opening the national markets to foreign participants, thereby increasing supply security and cost efficiency (Booz et al., 2013; Creti et al., 2010; Jamasb and Pollitt, 2005; Pellini, 2012). However, the European Commission has recently raised concerns that these goals may be undermined by national market design adjustments that are weakly harmonised across Europe (European Commission, 2013). Uncoordinated CRMs may distort cross-border trade and hinder the achievement of the Internal Electricity Market in Europe (ACER, 2013; RAP,

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2013). There are a few real-life examples for the interaction of energy-only and capacity markets: PJM and the Midwest ISO control areas in the US, Ireland and Great Britain, and Russia and the Nordic market. Inefficient cross-border trade has been observed in all the above cases (McInerney and Bunn, 2013; Viljainen et al., 2013). Experiences in these markets demonstrate how challenging the integration of electricity markets with different market designs can be. However, only a few recent studies focus on the impact of CRMs in Europe on cross-border trade and show that unilateral implementation of capacity mechanisms may cause cross-border effects and threaten the efficiency of the Internal Electricity Market (Sweco, 2014; Thema, 2013). The degree to which individual CRMs may impact trade depends on the interconnectivity between the markets, the correlation of prices and scarcity between the markets and coordination of the possible cross-border impact with the neighbouring market.

Capacity mechanisms can affect both short-term pricing and long-term investments. In the short-term, CRMs may lead to cross-border effects if regulation directly affects the bidding behaviour or market pricing in the energy market. Moreover, in the long run, CRMs may have impacts on investment decisions and thereby affect the long-term generation mix, electricity prices and electricity trade between markets.

CRMs can have multiple cross-border effects:

- *Price effects*. Significant decrease in super peak and peak prices. Capacity markets typically aim to reduce peak prices by replacing the sole energy-based remuneration of generators with two-part payments consisting of energy-based and capacity-based payments.
- *Capacity effects*. Even capacity mechanisms that do not directly influence the domestic price mechanism may have an indirect capacity effect by inducing more investments which in turn affect the merit order and energy prices. Negative cross-border effects occur, if generation investments are triggered in regions that have CRMs, while investments in other regions become less attractive.
- *Welfare effects*. In the case of positive externalities, the introduction of capacity markets involves a free-riding effect. Consumers in a country with capacity market may pay for an increase in generation capacity that partly leaks to the neighbouring market. Given the integration of markets through market coupling, consumers in the "passive" market may act as free-riders, since they benefit from an increase in reliability and lower energy prices without having to pay for the additional capacity. On the other hand, CRMs may also incur negative externalities. A reduction in price spikes in the CRM market limits the export prospects of the neighbouring market. The generators now depend on domestic price spikes, which may aggravate the missing money problem. In other words, a capacity market in one country may partly export the missing money problem to the neighbouring country, forcing it to change its own market design.
- *Infrastructure investment*. CRMs can distort investment incentives to build new interconnectors in the case of reduced trade leading to lower congestion rents for the interconnector owners (Meyer et al., 2014).
- *Distributive effects*. CRMs may significantly redistribute surpluses from consumers to producers or vice versa in both the active market that implements the capacity mechanisms and the passive market affected by the resulting cross-border effects.

This paper examines cross-border effects of two forms of CRMs, a strategic reserve (SR) and reliability options (RO). Based on a two-country model, the strategic interaction between the policy decisions of both markets is analysed from a game-theoretic perspective, that is, from the viewpoint of national policy makers optimising their own market's welfare by their strategic decision on market design. Section 2 details the discussion on capacity mechanisms in Europe, illustrates the missing-money problem, and briefly explains the functioning of CRMs. Section 3 describes the modelling approach used to analyse CRMs. The results are presented in Section 4, while Section 5 provides a discussion of further aspects and determinants of cross-border effects. Section 5 concludes.

2. Discussion on CRMs in Europe

2.1. Rationale for capacity mechanisms in the European member states

Electricity markets across Europe have traditionally been "energy-only" (EO) markets. Electricity generators are paid for the volume of electricity (MWh) they produce and sell to the wholesale market. In fairly competitive energy markets, energy payments should generate sufficient revenues to cover both the variable and fixed costs of the power plants. In the absence of market distortions, these revenues should suffice to attract new investment to ensure generation adequacy in the long-run (Hogan, 2005). However, there are critical assumptions for the energy-only markets to work, which may not be met in real-world markets. Notably, peak-load generators strongly depend on high price spikes, as they are dispatched only rarely and are characterised by a high marginal production cost. Such high price spikes may be prevented for instance by regulators or market authorities implementing explicit or implicit price caps or by regulatory uncertainty. As a result, there is a risk of "missing money" in energy-only markets leading to a shortfall of revenues to provide adequate investment incentives (Cramton et al., 2006; Joskow, 2006).

For the case of Europe, however, explicit price caps may hardly constitute a risk for generation adequacy, given that market prices are not directly regulated in most countries. Europe's main problem rather stems from the strong growth of renewable energy supply (RES) by means of ambitious support schemes. This development has led to current overcapacities in the market. The low marginal cost of RES generation creates a merit order effect by shifting the supply curve to the right. Thereby, both prices and load factors of conventional power plants are reduced. The decline in operating hours of combined-cycle gas turbines (CCGT) in some EU countries has already been observed and forecasted for the future years (Pöyry, 2011). In Spain, for instance, CCGTs were dispatched for only half as many hours in 2010 compared to 2004. As a result of the reduced number of operating hours and suppression of real scarcity prices, peak generators fail to recover their fixed costs. An increasing number of recently built CCGTs, which are highly efficient but not operating on a profitable basis, are at a risk of being mothballed unless market provides a higher remuneration across Europe. Ten of Europe's largest power companies announced mothballing of a total of 21.3 GW of gas power plants in 2013 (Caldecott and McDaniels, 2014). What may partly be a normal market clearing process may in case of an overshooting endanger supply security in the long run. Conventional peak generators are required to back up increasing shares of RES with a high variability and low predictability of output. Due to concerns that energy-only markets alone might not be able to deliver sufficient reserve capacity to compensate for shortfalls of RES during periods of low wind and sun, several European member states consider to redesign their energy-only markets and establish different forms of capacity remuneration mechanisms (CRMs) to incentivise continued operation as well as investments in new generation capacity (Eurelectric, 2011; Meulman and Meray, 2012; Nicolosi, 2012).

2.2. Capacity mechanisms

The aim of CRMs is to ensure the profitability of existing power plants and to support investments in new plants by providing stable revenues through capacity payments (Cramton and Ockenfels, 2012; Cramton and Stoft, 2005; De Vries, 2007; Joskow, 2008). To prevent the continuing closure of flexible peak generators, capacity payments should ensure fixed cost recovery for reserves to back up the growing share of RES (Brunekreeft et al., 2011; Cepeda and Finon, 2013; CREG,