Renewable Energy Support, Negative Prices, and Real-time Pricing

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Executive summary

Many countries around the world strive for high shares of renewable energy sources (RES) in their electricity systems. Fluctuating RES, such as wind power and solar photovoltaics, are likely to make up a major share, which confronts policy makers with a number of challenges. One of them is the choice of an appropriate support instrument that can achieve a given RES target most efficiently. A major concern in that regard is that RES support instruments have distortionary impacts on prices, which differ between instruments with respective consequences for efficiency.

In this article we compare two of the most widely employed support instruments: a subsidy on production, often called a market premium on energy or feed-in premium (FiP), and a subsidy on investment, often called a market premium on capacity or capacity premium (CP). The former can give rise to negatives prices up to the (negative) level of the premium, while the latter does not. Common wisdom thus suggests that the FiP would be generally less efficient than the CP due to the deviation from marginal cost pricing. We also consider varying shares of consumers with real-time pricing (RTP) tariffs, which resembles the situation in many markets worldwide where most consumers still face time-invariant retail prices. Apparently, the effect of price distortions induced through RES support depends on the degree to which consumers react to prices.

The analysis is based on a stylized long-term partial equilibrium model of the power sector, which is calibrated to German market data. A regulator sets the level of either premium so that in the long run a given share of renewable energy in overall production (relative target) is attained. Costs for overall premium payments to RES producers are carried by consumers via a time-invariant levy paid on top of the wholesale price for power. The focus of the analysis is on the difference of "consumer" welfare, i.e. net consumer surplus, between the two instruments.

Contrary to the above intuition that an instrument that induces negative prices is less efficient, we find that a FiP can actually lead to higher welfare than a CP. This is because a RES production target can be achieved at lower overall costs, since less RES capacity is required to obtain a given share in total production. More precisely, negative prices during hours of high RES supply incentivize RTP consumers to raise their consumption more than under the CP regime, where retail prices never drop to or below zero. Thus, RES capacities are utilized to a relatively larger extent than under the CP, implying that the same RES production target is achieved with less RES capacity entry. The Figure shows the welfare differences between FiP and CP for the base case.

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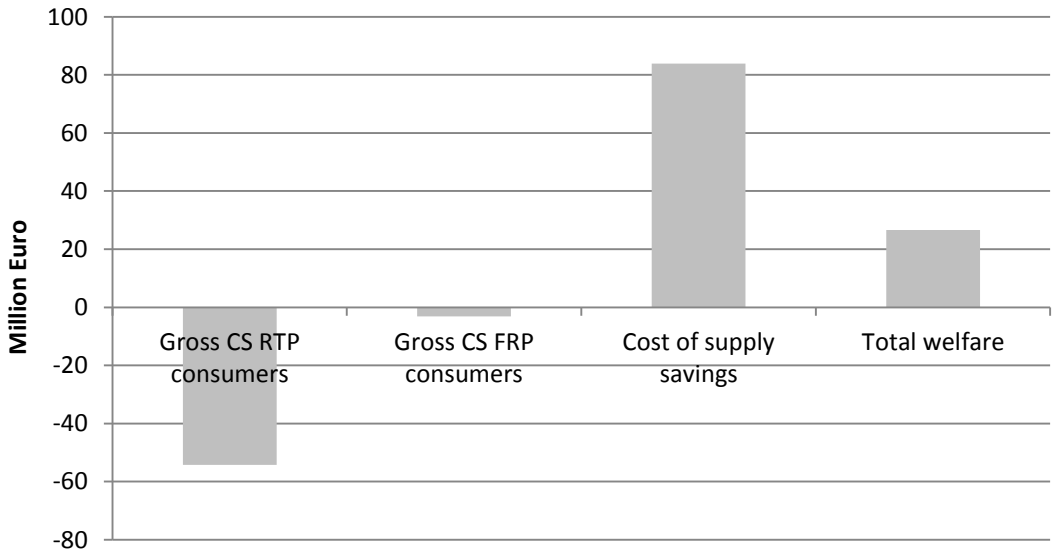

Figure: Decomposed net consumer surplus (welfare) differences if changing from CP to FiP, in € million/year.

Another important result relates to the effect of increasing the share of RTP consumers. In particular for the FiP and its relatively stronger distortionary effect on prices, higher RTP shares mitigate respective welfare losses due to allocative inefficiencies arising from over- and under-consumption given a fixed retail price. Moreover, broken down to consumer groups, surplus gains are markedly higher for consumers who switch from FRP to RTP under the FiP. This has an important implication: assuming that these surplus gains will be fully internalized by the respective consumers, there are accordingly higher incentives for consumers to switch under the FiP.

Notwithstanding our results, negative prices warrant caution because they could have further implications beyond the scope of this work, which may be of high practical importance. For example, we do not explicitly consider cross-price elastic behavior (load shifting), and we abstract from endogenous investments to exploit negative prices. In practice though, RTP consumers might indeed exploit negative prices by investing in smart appliances, and it is unclear if this would increase their inclination for consumption in other hours as well. Thus, the structural consumption pattern could change and differ from the one we assume. Moreover, empirical evidence for price-elastic behavior at times of low or negative prices is so far rather poor, and actual effects might well deviate from our results in either direction. In summary, while our findings are primarily of theoretical nature and the full range of implications of negative prices needs to be carefully considered, we hope that our analysis makes policy-makers more considerate of their potential benefits.

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