

Cost Efficient Regulation of the Danish Agricultural Discharges of Nitrogen to Coastal Waters – Economic analysis of total cost and the distribution of cost.

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Nitrogen discharge from the Danish agricultural sector negatively affects the ecological status of Danish coastal waters. According to the Water Framework Directive, Denmark is obliged to reach good ecological status in all its coastal waters. To achieve this goal of good ecological status it is necessary to regulate the agricultural discharges of nitrogen. We analyse the cost effectiveness of several types of such nitrogen regulation, taking the national nitrogen discharge reduction targets of 2021 as given. The reduction targets are separately specified for 90 different water catchment areas.

We model the costs and impacts of different types of regulation within each water catchment area, taking account of spatial differences in farm type mix and retention rates, i.e. the soils ability to prevent leached nitrogen to be discharged to the coastal water. This is done by combining a partial equilibrium model of the Danish agricultural sector (ESMERALDA) with detailed geographic information about the joint distribution of farm types and retention rates in each of the 90 water catchments.

We find that the most cost efficient type of regulation is a targeted crop tax. Under such a tax, each farm pays a tax per hectare depending on the crop choice as well as the soil type, the local retention rate and the size of the local reduction target in the water catchment area. The tax is higher if the reduction target is high, if the retention is low or if the leaching from the chosen crops is high. The crop tax is combined with a targeted tax on livestock units, which corresponds to the extra discharge caused by using manure instead of artificial fertilizers.

We also find that regulation based on the principles of the former Danish regulation system – so-called nitrogen allowances – is more costly than the targeted crop tax. This is true even if the nitrogen allowances are targeted towards differences in retention rates and reduction targets. Nitrogen allowances are more costly because they impose regulation further away from the environmental impact, i.e. on input of nitrogen instead of on discharges.

A targeted crop tax has additional beneficial features. We show that a targeted crop tax gives better incentives than nitrogen allowances to place high-emitting production where reduction targets are low and where the retention rate is high. We also show that a targeted system of nitrogen allowances gives incentives for farmers to trade nitrogen illegally, because the value of one kg will differ severely between some farmers. We estimate the costs of achieving the reduction targets if such trade takes place. These costs can more than quadruple the cost of achieving the reduction targets in all catchment areas. Targeted crop taxes do not suffer from such adverse incentives to illegal nitrogen trading.

Finally, we consider distributional impacts of different types of regulation. We suggest a transfer mechanism, which returns the tax revenue to farmers without causing adverse incentive effects. We show that this transfer mechanism makes targeted crop taxes the least costly type of regulation for most farmers.

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