Extended Abstract
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Paper/Poster Title	**Yield and profitability impacts of reducing fertilisation in nitrate-polluted areas: Evidence from a spatial regression discontinuity design in Bavaria, Germany**

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Abstract	***200 words max***
In 2016, the European Commission referred Germany to the Court of Justice of the EU over water pollution caused by nitrates, which is mainly caused by agriculture. As a response, the national government decided to take stronger measures to combat water pollution. Among these measures was the designation of heavily nitrate-polluted areas, in which farmers have to reduce nitrogen fertilization by 20% below the plants' estimated needs and thus presumably below the optimal intensity. As farms located in these areas are not offset for potential yield and profitability losses, concerns arise about the legitimacy of the approach as well as about potential leakage effects. Applying a Regression Discontinuity Design and a production economic framework on panel data of farms in the German Federal State of Bavaria, we find that the new regulation negatively affects agricultural yields and farm profitability.	

Keywords	Regression Discontinuity Design, Difference-in-Difference, Policy Evaluation, Nitrate in Groundwater, Farm Profitability, EU Nitrates Directive
JEL Code	Q18, Q12 see: www.aeaweb.org/jel/guide/jel.php?class=Q)

Introduction	***100 – 250 words***
Germany has consistently exceeded the European Union's (EU) maximum levels for nitrate in groundwater since the introduction of the EU Nitrates Directive, mainly due to fertilisation in agriculture, resulting in a decades-long tug of war with the European Commission. In an attempt to avoid sanctions, the national government restructured its nationwide fertilisation ordinance in 2020. The new rules included the designation of heavily nitrate-polluted areas, in which, among others, farmers have to reduce nitrogen fertilization by 20% below the plants' estimated needs. This guideline provoked protests among farmers' associations. They fear yield and profitability losses as well as leakage effects and higher costs to guarantee food security. Against the background of this fears and calls for equal production standards on competitive markets, our paper analyses the effect of the 2020 regulation of farm-level production effects and profitability.	

Methodology	***100 – 250 words***
Using Bavaria, a Federal State located in Southeast Germany, as a case study, we combine farm-level (socio-)economic and geo-referenced field-level panel data	

(2016-2021) to in a first step estimate farm productivity and profitability based on indices proposed by O'Donnell (2012). In a second step, we develop a Regression Discontinuity Design (RDD) to determine the causal effects of the new fertilization rules on farm production and profitability. The cutoff or threshold to be used for the intervention are the borders that have been defined for heavily nitrate-polluted areas. By comparing farms operating closely on either side of this border, we try to estimate hypothesized effects. As the RDD rests upon the assumption that the treatment assignment is "as good as random" for the farmers, we additionally perform a Difference-in-Difference (DiD) estimation as a check for robustness.

Results	***100 – 250 words***

Our results suggest that the new fertilisation regime does in fact negatively affect yields on arable land. The yield effects are, however, moderate. When considering input use and outputs generated, i.e. productivity, we find that farmers successfully adapt their crop mix to the new rules. Additionally accounting for prices, though, shows that farms located inside the heavily nitrate-polluted areas do face profitability decreases compared to the control group outside these areas. This raises concerns as regards equity given that local conditions (e.g. soil type, precipitation) influence nitrate concentrations in groundwater to a great extent.

Discussion and Conclusion	***100 – 250 words***

The main assumption behind the RDD we apply is that the treatment assignment is random. We are confident that this assumption holds in our setting given that farmers inside and outside the nitrate-polluted areas were not involved in the decision about the zoning. However, through their management practices they might indirectly have influenced the decision. For this reason, the robustness of our Regression Discontinuity analyses is checked with a Difference-in-Difference estimator assuming common trends for unobservables. The DiD estimates confirm the RDD results. We conclude that the protests of farmers' associations against the new fertilisation rules are to some extent justified and that policymakers might think of an instrument that provides the ecosystem service "clean drinking water" more efficiently.