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PREDICTING WHICH FARMS ARE MOST LIKELY TO BREACH NITRATE POLLUTION REGULATIONS

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Predicting which farms are most likely to breach nitrate pollution regulations[1]

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INTRODUCTION

We present an example of how so-called "big data" can be used to assist enforcement of environmental regulations. Every year approximately 2,000 farms in Ireland violate the EU Nitrates Regulations. Although small as a proportion of over 130,000 farms, this number has varied little in recent years, reducing water quality and leading to penalties for farmers. We analysed the characteristics of farms and farmers that had exceeded the regulatory limit on nitrogen per hectare (NPH). We combined digital files from the Department of Agriculture to generate a single dataset containing over 1.2 million records that detail annual nitrates emissions on individual Irish farms from 2006 to 2015. The aim was twofold: to understand factors behind noncompliance and to build a predictive model that can be used to target behavioural interventions designed to help farmers to comply.

DATA AND METHODS

We worked in collaboration with the Department of Agriculture, Food and the Marine (DAFM) to combine many disparate spreadsheets, which are generated each year to support enforcement, into a single, comprehensive dataset covering 2006-2015. The resulting 1,290,000 individual records contained information for each individual farm in each year. As well as nitrates emissions, the dataset included the size of the farm, age of the farmer, farm ownership structure and historical variables relating to registration with the Department and previous history of compliance. The primary outcome of interest was the likelihood of

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exceeding the 170 Kg NPH limit. The data were analysed using statistical models covering the whole period and separate models for each individual year. Some models were fitted to data for the years up to 2014 and then used to predict compliance in 2015.

RESULTS

Farms with more previous violations and higher NPH in recent years were at greater risk of noncompliance. While this is unsurprising, the steady increase in the likelihood of noncompliance (rather than a threshold level above which farms are at substantially greater risk) implies that many violations are not due to small changes in behaviour, but instead reflect substantial changes to business practice. Farms with smaller land holdings and (more surprisingly) younger farmers are also more likely to violate the regulations. Overall, the findings are consistent with the view that regulatory violations are most likely when a farm business undergoes substantive change, perhaps via an alternative business model, expanded production, or the buying or selling of land. Noncompliance was also higher in Eastern counties with more fertile grassland, where farmers may be more likely to expand operations to meet short-term market conditions.

We compared the predictive performance of the statistical models against a rule-of-thumb used by DAFM, which is to target farms above 150 Kg NPH. Our statistical models are more accurate than this rule-of-thumb in predicting which farms are likely to violate the 170 Kg NPH limit. For instance, the models allow the number of targeted interventions to be reduced by at least 18% while still contacting a higher number of farms likely to breach the regulations.

POLICY IMPLICATIONS

We highlight four implications. First, our analysis gives insight into violations of the Nitrates Regulations that can assist in the design and targeting of interventions aimed at improving compliance. Examples of interventions include warning letters and targeted information. Interventions may be more successful where they are well-timed, reminding farmers of their obligations when changes to business practice are being considered, such as when trading livestock or engaging an advisor. Second, the predictive performance of the model means that it can be used to target interventions at those farms most likely to breach the limit. Third, improving the quality and scope of administrative data could permit future research using multiple experimental tests of interventions via randomised controlled trials. Finally, and more broadly, this paper demonstrates how it is possible to use administrative “big data” to support regulatory enforcement.

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