Extended Abstract
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Paper/Poster Title	**Farm-Level Assessments of Greenhouse Gas Marginal Abatement Cost Curve Emissions: Understanding the Implications of Interactions and Heterogeneity**

Abstract prepared for presentation at the 97th Annual Conference of the Agricultural Economics Society, The University of Warwick, United Kingdom

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Abstract	***200 words max***
Mitigation of climate change remains a central focus of the global communities. In Ireland, GHG emissions from the agricultural sector are disproportionately high compared to other developed countries at 37.5% of total greenhouse gas emissions (GHG). Extensive efforts have been brought to bear on the development and evaluation of mitigation measures that reduce greenhouse gases from the agricultural sector. However, the extent to which mitigation measures reduce GHG emissions at the farm-level has received less attention, most especially the implication of farm heterogeneity on optimal emission reduction. Using EU Farm Accountancy Data Network data for the Republic of Ireland in 2020, this study engages the use of Marginal Abatement Cost Curve (MACC) to assess a suite of mitigation measures across GHG and account for interaction and heterogeneity effects across 5 different farm system types. The result of the study showed that reduction in the crude protein fn concentrate feds is the most cost-effective measure for all the farm systems. Other measures, typically liming and protected urea are also cost-effective. The finding showed that no two MACC curves are the same with the rankings of measures changing from one farm system to the other. In addition, the combination of mitigation measures to reduce GHG emissions may not necessarily yield a overall cost-effective outcome.	

Keywords	**climate change, mitigation, GHG, farm-level, heterogeneity**
JEL Code	Climate; Natural Disasters and Their Management; Global Warming, Q54 see: www.aeaweb.org/jel/guide/jel.php?class=Q)

Introduction	***100 – 250 words***
The agricultural sector is required to reduce its GHG emissions in the context of Ireland's commitment to reduce national GHG emissions and achieve climate neutrality by 2050. Under the Paris Agreement, the EU has a 40% reduction target of GHG emissions in 2030 relative to the 2005 scenario, these target levels are trickled down to individual countries in the EU. For Ireland, this implies a 30% reduction level in GHG emissions compared to 2005 to be achieved by the 2030 commitment period (EPA, 2022). The Climate Action Act 2021 of the Republic of Ireland sets down a 25% emissions reduction target for agriculture by 2030 from a 2018 base. This implies a	

reduction in emissions from 22.04 Mt CO2eq in 2018 to circa 16.5 Mt CO2eq by 2030 (DCCAE, 2021).

While several studies exist on the assessment of the abatement of GHG emissions in Ireland and the global community at large at an aggregate scale. Very few studies (Jones et al., 2015) have considered assessing the importance of farm heterogeneity and interactions amongst abatement measures. The apriori expectation of this study argues that "one type fit all" approach to assessing MACC is not optimal for policy design. Thus, building on the previous work by Lanigan et al. (2018); , this study seeks to 1) Assess the abatement potential, cost and cost-effectiveness of a suite of GHG mitigation measures 2) Explore the effect of farm system heterogeneity of difference GHG based mitigation measures using Marginal Abatement Cost Curve (MACC) based methodology 3) Examine the effect interactions amongst abatement measures.

Methodology

100 – 250 words

The estimation of data is based on the IPCC based national inventory accounting methodology (as implemented by the Environmental Protection Agency in Ireland) where the total farm level GHG emissions are estimated by multiplying the farm's activity levels with the associated emission factor of a particular activity as shown in equation (1) below.

$$Total\ GHG = \sum_{i=1}^{n} (Activity\ data * Emission\ factor) \quad (1)$$

Data on emission factors were obtained from the Irish National Inventory Report (EPA, 2020), and farm-level activity data were obtained from the Teagasc (Irish Agricultural and Food Development Authority) National Farm Survey (NFS) 2020 dataset which is part of the European Union (EU) Farm Accountancy Data Network (FADN).

Five farm types were considered in this study and they include dairy, cattle, sheep, tillage and mixed livestock. However, it is noteworthy that the farm types only represent the dominant enterprise and that these farms can have multiple enterprises.

Abatement measures considered in the study can be broadly categorised as the fertiliser measures (liming, protected urea and clover) and manure management options (slurry amendments, low emissions slurry spreading techniques, covering of slurry and reduction in the crude protein of animal diets)

Results

100 – 250 words

The results of our study buttressed the importance of the selected the most cost-efficient measureat farm level to reduce GHG emissions. Results indicate that the behaviour of abatement measures differs across the different farm systems. While certain measures such as liming and protected urea behaved well across the different farm systems, the behaviour of certain measures changes with the farm system under consideration.

Furthermore, the results of the MACC diagram showed that the ranking of the abatement measures changes across the different systems with no two MACC having the same ranking of abatement measure. In addition, the interaction of abatement measures doesn't necessitate a cost-effective outcome. For instance, while the combination of measures led to a cost-beneficial scenario for the dairy and tillage farm, but it was cost-positive for the other farm types.

Discussion and Conclusion

100 – 250 words

This study reveals that across the different farm system types that there exist variations in the mitigation measures' abatement potential, abatement cost and cost-effectiveness. This reflects the presence of farm heterogeneity across the different farm systems. While the literature on GHG MACC is vast, those investigating the presence of heterogeneity on farms are very limited, especially in the Republic of Ireland.

For example, results of this study indicate that the ranking of clover as a mitigation measure varies between a cost-beneficial to a cost-effective measure. These variations are mainly due to activity levels of the different farm types which affect the optimality of GHG emission reduction. This study concludes that failing to account for farm-heterogeneity in policy could lead to sub-optimal levels of emission reductions and that a combination of mitigation measures in form of interactions does not necessarily lead to a cost-effective solution since different farms behaved differently with the interactions of mitigation measures.