Extended Abstract
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Paper/Poster Title	Measuring pig farmers' practices concerning the use of antimicrobials: A case study of four European Countries

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Abstract	200 words max

Pig farming has been identified as one of the sectors in which antibiotics use drives the development of antimicrobial resistance (AMR), hence resulting in increasing public concerns. However, to minimise AMR (specifically antibiotics resistance) pig farmers may need to embrace technological innovations and practices that are specifically targeted. This study investigates Strategies, Attitudes and Practices (SAP) of pig farmers towards biosecurity measures and potential technological measures that could lead to the reduction of antibiotics at the farm level. In this light, a survey, based on a randomly selected sample, with pig farmers (N=600) across four EU member states (Germany, Italy, Netherlands and Spain) was conducted in January 2021. Results show some statistically significant differences in the practices employed by farmers in reducing antibiotic use between countries. We also explored the practical feasibility of adopting some technological and innovations measures (e.g., environmental enriched provisions, real-time warning of individual behaviour, sound equipment and accelerometers) that could help pig farmers to minimise the usage of antibiotics. To achieve this, Principal Component Analysis and Binary Logistic regression to identify the factors influencing the adoption of the proposed technologies are employed. Results show that most of the farmers are more likely to adopt some measures/practices (e.g., environmental enriched provision such as deep straw) to reduce antibiotic use. The study also reveals some clear statistically significant differences across the countries. This is particularly useful in exploring the adoption of various practices and innovation strategies that would best suit each country in reducing antibiotics usage in pig farms across the entire EU.

Keywords	AMR, antibiotics usage, pig farmers attitudes, technological innovations, Principal Component Analysis (PCA), binary logistic regression, EU
JEL Code	Econometric and Statistical methods: General C8 see: www.aeaweb.org/jel/guide/jel.php?class=Q)

Introduction	100 – 250 words

In many EU countries, the usage of antibiotics to prevent and treat bacterial infections is relatively high, especially in pig farming (Grave et al., 2010). Thus, to keep it as effective as possible it is important to reduce their application within the pig farming sector. This is because the extensive use of antibiotics is known to enhance the development of bacteria that are resistant to antibiotics and as such there is bound to be a growing problem in animal and health management (EFSA and ECDC, 2013). Hence, a successful reduction of antibiotics use depends on whether farmers are willing to opt for alternative measures such as biosecurity and technological innovations to combat diseases in pigs. Pig farmers' decision making and their practices regarding antibiotics can be determined by various factors such as external/physical

factors (e.g., the number of pigs kept on their farm or the housing conditions) but also by the farmer's characteristics (physical variables) (e.g., age and gender) (Visschers et al., 2014). Additionally, some 'internal' variables might also have an impact on farmers antibiotic usage. These may include attitudes and practices of farmers towards antibiotics use as well as their attitudes towards biosecurity and potential technological innovations. Thus, to develop and apply effective interventions/measures or technologies that reduce the use of antibiotics among farmers, it is important to explore the physical, internal, and external variables related to antibiotic use. Several studies have investigated pig farmers' attitudes and practices which include the use of alternative measures such as biosecurity to prevent, treat and control diseases in their pigs (e.g., Fraser et al., 2010; Simon-Grifé et al., 2013). However, to the best of the authors' knowledge, no studies have investigated farmers' strategies, attitudes and practices towards a set of proposed technological innovations and measures as explored in this study.

Methodology	*100 – 250 words*

A cross-sectional survey was conducted among 600 pig farmers located in Germany (n = 150), Italy (n=150), Netherlands (n = 150) and Spain (n = 150), referred as GINS in this study. Hence, the survey was distributed in geographically representative four EU countries. A purposeful quota sampling technique was used to obtain samples representing pig farmers in each of the four (GINS) surveyed countries. The questionnaire included 50 items which encapsulates sections such as demographics, participants' practices and attitudes towards antibiotic use and participants' attitudes towards biosecurity and potential technological innovations. A Likert-e points scale was applied for most questions. Descriptive statistics were calculated for GINS farmers' demographic characteristics as well as their strategies, attitudes and practices. Additionally, Analysis of Variance (ANOVA) was used to compare farmers' attitudes and practices between countries. Comparisons between categories of GINS farmers were performed and a Principal Component Analysis (PCA) was used to reduce the attitudinal variables to a number of components. This was analysed to produce a picture of the actual differences in farmer's behaviour and attitudes across countries. This is geared towards finding the differences in attitudes between (pig) farmers and possible explanatory variables (Linting and van der Kooij, 2012) across GINS countries. As the data in the study consisted of nominal, continuous, and ordinal variables, a non-linear analysis was also employed via a categorical PCA. Categorical Principal Component Analysis can manage possibly nonlinearly related variables with different types of measurement level and it is particularly adapted to analysing Likert scale type of variables (Linting and van der Kooij, 2012).

Results	*100 – 250 words*

In total, 600 farmers participated in the survey, 552 males and 48 females. Respondents were presented with four major strategies that are said to help in reducing the use of antibiotics at the farm level. GINS farmers ranked the four strategies significantly differently. 'Improving resilience in pigs' and 'improving biosecurity' are the first ranked strategies chosen in the GINS countries. Participants' practices towards antibiotic use revealed *inter alia* that Italian farmers are less likely to purchase antibiotics from a veterinarian than from an animal pharmacy (38% vet and 68% animal pharmacy) whereas most of them would prefer to seek advice from veterinarian when their pigs are sick than from an animal pharmacy (95% versus 4%). In contrast, all German, Dutch and Spanish pig farmers would likely buy antibiotics from a veterinarian than from an animal pharmacy or other providers. This corroborates their actions and/or practices in terms of seeking advice from veterinarians when their pigs are sick. We also investigated the acceptance and adoption of several proposed technologies identified in our study. These technologies are classified into two major categories to indicate whether they could be useful in early detection of diseases or in increasing resilience in pigs. Over a third (35%) of the respondents also agreed that they would find an automatic weighing system as

well as a sound equipment very useful in measuring individual pig weights and monitoring vocalisation and coughs respectively. Nevertheless, only 23% of them indicated that they will likely adopt the use of such technology. Most of the respondents (47%) reported that they do not find free farrowing pens as a useful practice and they may not be keen to adopt it. This may infer that GINS farmers might prefer a technology that detects diseases early to one that increases resilience in pigs.

Discussion and Conclusion	*100 – 250 words*

This study investigated pig farmers' Strategies, Attitudes and Practices towards the usefulness and adoption of some proposed technologies and measures that may aid the reduction of antibiotics in four EU countries. use. The sample was representative of the pig farmer' population in the investigated countries and the results revealed three key findings. First, there are differences between farmers across countries regarding the Strategies they use, their Attitudes and Practices towards the use of antibiotics. Second, the use of deep straw as a component of the environmental enriched provision for reducing antibiotics use is the most embraced practice. Third, veterinarians are the most appropriate to inform and advise pig farmers about antibiotics use, and in general farmers reported as being satisfied with the advice received from veterinarians. Other studies also corroborate that veterinarians are the most preferred and trusty 'source of information' regarding pig farming (Garforth et., 2013, Xiaocheng et al., 2013). In terms of strategies, the results show that improving resilience in pigs and improving biosecurity are the most preferred. Regarding practice adoption and usefulness, free farrowing is less attractive across countries. The interaction between farmers and veterinarians is also explored and the role of veterinarians in reducing antibiotics use cannot be overemphasised. Participants in this study showed high level of confidence in veterinarians and this suggests that veterinarians could play an important role in supporting and advising farmers on using antibiotics more responsibly.