Extended Abstract

Paper/Poster Title	**Payments for agri-environmental schemes and green productivity in Germany: An impact assessment analysis**

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Abstract	***200 words max***
This study offers a novel empirical application for assessing the impact of agri-environment schemes (AES) on the performance of farms. The existing evidence about the environmental and economic impact of these schemes is still limited. Therefore, our objective is to contribute to the literature on the impact evaluation of AES by considering three important aspects in our empirical analysis. First, the performance of farms is proxied by an indicator that incorporates environmental externalities (nitrogen pollution) into production activities. Second, our empirical analysis focuses on a sample of Bavarian dairy farms covering the period 2013-2018, thus, we can evaluate the effectiveness of Europe's agri-environmental schemes during the latest programming period. Finally, in an effort to increase robustness, we employ an improved version of the Malmquist-Luenberger productivity index, which enables us to get around some of the shortcomings of the original index. The obtained results suggest that agri-environment payments have a limited effect on improving farm-level green productivity.	

Keywords	Agri-environment schemes, Policy evaluation, Green Productivity, Data envelopment analysis,
JEL Code	Q12, Q56, Q18, C61

Introduction	***100 – 250 words***

In general, an AES consists of a set of (environmentally friendly) measures that farmers are expected to perform, with associated payments. The goals of AES are to promote or maintain the good effects of agriculture while reducing the harm that agricultural operations cause to the environment. Both goals shall be reached with AES design that is compliant with domestic support rules of the World Trade Organization (WTO). According to these rules, agricultural subsidies may only be granted if they qualify for the so-called “Green box”, i.e., if they “have no, or at most minimal trade-distorting effects or effects on production”. Furthermore, “the amount of payment shall be limited to the extra costs or loss of income involved in complying with the government programme”. From a production theoretical perspective, it is unclear whether AES programmed under the CAP do meet the WTO requirements. Some empirical evidence exists that casts doubt in this respect (Mennig & Sauer, 2020) . However, these authors do not use comprehensive indicators to measure production effects and focus only on marketable outputs. If, though, production effects are defined in a broader sense covering marketable and non-marketable (environmental) goods, negative impacts of AES on yields, for example, might be offset by positive environmental effects. In terms of “green productivity”, AES might even have an enhancing effect, making them an important instrument in increasing agricultural production while, at the same time, reducing the burden agriculture puts on the environment and possibly being in line with WTO requirements.

Methodology	***100 – 250 words***

Our analytical framework consists of three steps:

1. We use propensity score matching (PSM) to control for potential selection bias arising from observable characteristics. The matching procedure aims to select a group of non-participating farms whose characteristics are similar to the treatment group. Once PSM has been performed and comparable participants and non-participants observations have been identified, the GML index can be applied to both groups to determine unbiased estimates of productivity, efficiency, and technical change.
2. Nowadays, the Malmquist-Luenberger index developed by Chung et al. (1997) is the most widely used to evaluate productivity change over time when both desirable and undesirable outputs are produced. However, as it has been shown by Aparicio et al. (2013), the Malmquist-Luenberger index suffers from

some weaknesses. Therefore, in this paper, we rely on the recently introduced Global Malmquist–Luenberger (GML) index (Oh, 2010), which is based on defining a global frontier that envelopes all observations for all periods.

3. Although PSM helps to control for potential selection bias due to observed factors, it has been shown that farmers' decisions to take part in agri-environmental programs may also be influenced by unobserved factors, such as the farmers‘ environmental motivations, which can be assumed to be relatively stable over time (Wilson & Hart, 2000). The use of difference-in-difference (DID) approach allows us to control for time-invariant unobserved heterogeneity. It involves comparing participating farms (treatment group) and their matched counterparts (control group), before and after the scheme’s implementation.

Results	***100 – 250 words***

The PSM results suggest that no significant differences between participating and non-participating farms remain after matching. We can therefore conclude that the applied matching algorithm worked well, as the existing observable differences have been controlled for.

The results of the GML index indicate that, on average, farms experienced a green productivity increase of 4.3% from 2013 to 2018. This productivity growth is mostly due to the positive evolution of technical change (+ 4.95%), while efficiency change is close to unity, indicating stagnation.

Regarding the impact of AES on green productivity, we adopt a simple way to calculate the DID estimates by using a *t*-test to compare green productivity change between the two groups. A positive (negative) DID coefficient indicates an increase (decrease) in the average GML values of the participants that is larger than the increase (decrease) of their matched non-participants. Results indicate that the impact of AES on the GML index is positive (0.06) but not statistically significant, suggesting that the average change in green productivity from 2013 to 2018 does not significantly differ between the participating and the non-participating farms.

Turning now to the potential impact of AES on the components of the GML index, the technical efficiency change, and the technological change, results show that the AES payments seem to have a significant and positive effect on efficiency change with an

average growth of 5.05%, while AES participation has been found to have no significant effect on technological change values.
Discussion and Conclusion ***100 – 250 words***
While agri-environmental policies were initially implemented to mitigate the detrimental effects of intensive agriculture systems on the environment, a number of studies have shown the potential of these agri-environment measures to strengthen the economic viability of agricultural holdings (Harkness et al., 2021). Given that economic considerations are important drivers of farm-level production decisions, evaluating the effectiveness and impact of environmental support programs cannot be done without examining the economic dimension. Our GML index that aimed at specifying green productivity indices is therefore based on this approach that accounts for both environmental and economic performances. From a theoretical perspective, it is reasonable to expect that AES will have a positive impact on green productivity, and at least should not prevent its improvement. The reasons for this belief are related to the fact that AES would stimulate input productivity, and relying on the Porter hypothesis theory, AES are expected to stimulate environmental innovation and thus improve green productivity. However, our results indicate that AES payments have a limited effect on improving farm-level green productivity with only a significant effect on efficiency change. The efficiency change component accounts for catching up effects that could include learning by doing, and improved production practices, which can be reasonably interpreted as the result of more optimal input use. Given this background, our findings may reflect technical and economic improvement induced by the agri-environmental programs. This effect is not expected as the schemes were implemented to improve environmental outcomes, but might reflect windfall gains.

References

Aparicio, J., Barbero, J., Kapelko, M., Pastor, J. T., & Zofío, J. L. (2017). Testing the consistency and feasibility of the standard Malmquist-Luenberger index: Environmental productivity in world air emissions. *Journal of Environmental Management*, *196*, 148–160. https://doi.org/10.1016/j.jenvman.2017.03.007

Aparicio, J., Pastor, J. T., & Zofio, J. L. (2013). On the inconsistency of the Malmquist–Luenberger index. *European Journal of Operational Research*, *229*(3), 738–742. https://doi.org/10.1016/j.ejor.2013.03.031

Harkness, C., Areal, F. J., Semenov, M. A., Senapati, N., Shield, I. F., & Bishop, J. (2021). Stability of farm income: The role of agricultural diversity and agri-environment scheme payments. *Agricultural Systems*, *187*. https://doi.org/10.1016/j.agsy.2020.103009

Mennig, P., & Sauer, J. (2020). The impact of agri-environment schemes on farm productivity: A DID-matching approach. *European Review of Agricultural Economics*, *47*(3), 1045–1053. https://doi.org/10.1093/erae/jbz006

Oh, D. hyun. (2010). A global Malmquist-Luenberger productivity index. *Journal of Productivity Analysis*, *34*(3), 183–197. https://doi.org/10.1007/s11123-010-0178-y

Wilson, G. A., & Hart, K. (2000). Financial Imperative or Conservation Concern? EU Farmers' Motivations for Participation in Voluntary Agri-Environmental Schemes. *Environment and Planning A: Economy and Space*, *32*(12), 2161–2185. https://doi.org/10.1068/a3311