Extended Abstract

Paper Title	German farmers' perceived usefulness of satellite-based index insurance – Insights from a transtheoretical model

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

27th – 29th March 2023

Abstract	***200 words max***

Index insurance is a promising tool to mitigate drought-related income losses in agriculture. Yet, the basis risk of index insurance based on meteorological observations inhibits farmers' demand. To reduce the basis risk, the integration of satellite data has received research attention. However, farmers' perceptions of satellite-based index insurance remain unknown. To derive initial insights into German farmers' perceived usefulness (PU) of satellite-based index insurance, we surveyed 127 German farmers in a risk management context and applied a modified transtheoretical model of behavioral change (TTMC). This revealed detailed information on German farmers' PU of satellite-based index insurance and its influencing factors. The results indicate that the average farmer perceives satellite-based index insurance as useful. Particularly, a higher educational level in the agricultural context as well as higher trust in index insurance products increases farmers' PU. Moreover, higher relative climate-related income losses increase farmers' PU. The results are of importance to insurers interested in the drivers of farmers' PU of upcoming satellite-based index insurance and offers a starting point for researchers focusing on acceptance of index insurance and satellite data as well as for further applications of the TTMU.

Keywords	Risk management, Index insurance, Transtheoretical model
JEL Code	Q12

Introduction	***100 – 250 words***

Climate risks, particularly droughts and heat waves, occur more frequently and affect crop yields negatively in Central Europe (Grillakis, 2019; Schmitt *et al.*, 2022). To mitigate economic effects, index insurance is discussed. Index insurance is cost efficient, reduces the problem of asymmetric information, allows quick determination of payouts and addresses moral hazard and adverse selection. However, since the referred index of insurance products based on meteorological measurements is independent of the yield on a specific field, it cannot reflect the yield loss perfectly, creating a basis risk (Clement *et al.*, 2018). Although a country like Germany has a dense network of weather stations, this kind of idiosyncratic event might be missed. Overcoming this problem is of great importance for the adoption of index insurance (Clarke, 2016). By integrating various satellite data, a reduction in basis risk was found

compared to meteorological measurements. Therefore, from a theoretical point of view, satellite data potentially increase the attractiveness of index insurance for farmers. However, evaluation of farmers' perceptions remains necessary (Vroege *et al.*, 2021). Therefore, to the best of our knowledge, this study is the first that deals with the PU of upcoming satellite-based index insurance. This is of high relevance as farmers' PU was associated directly to the adoption of new technologies in previous research. Germany is of particular interest because only about 1% of farmers have index insurance despite a dense network of weather stations and a nationwide catastrophic drought in 2018 that caused considerable yield losses for several crops.

Methodology	***100 – 250 words***

In 2021, an online survey addressing German farmers was conducted. Based on the framework proposed by Pierpaoli *et al*. (2013), potential influencing factors on the PU were investigated. Accordingly, farmers were asked to give information on their socio-economic and farm characteristics. Moreover, farmers were asked for their general risk attitude, their attitude of confidence in index insurance products and the relative effect of climate risks on farm income. To investigate German farmers' PU, the TTMC developed by Prochaska and Velicer (1997) was modified and applied as a transtheoretical model of PU (TTMU) which accounts for more than two stages of PU. Although the application of the transtheoretical model is scarce to investigate farmers' PU compared to Likert scales or binary choices, it is appropriate as it captures the decision-making process gradually at a given point in time. Likewise, one farmer perceives the use of satellite data for index insurance as useful while another does not, resulting in them being at different stages of PU. In turn, other farmers might perceive that the use of satellite data could be very useful at the current point in time, which is also another stage of PU. In agricultural research, the application of the TTMC has received little attention. Indeed, the TTMU, as a new specification of the TTMC, has not been applied in an agricultural context. As our modified TTMU question is ordinal with four possible categories, an ordered logit model was estimated.

Results	***100 – 250 words***

127 farmers fully completed the survey and were included in the statistical analyses. The results show that the average farmer perceives satellite-based index insurance as useful. Results of the ordinal logit model show that a higher educational level in the agricultural context as well as higher trust in index insurance products increases farmers' PU in a statistically significant way. Moreover, higher relative climate-related income losses increase farmers' PU in a statistically significant way. More specifically, the marginal effects show that farmers who perceive satellite-based index insurance as useful differ from farmers for whom it could be very useful in the statistically significant variables, providing first insights into potential early adopters. Other possible influencing factors like farm size, livestock farming, soil quality, age, gender, full-time farming and the general risk attitude have, against the expectation, no statistically significant effect on the PU.

Discussion and Conclusion	*100 – 250 words*

Index insurance in general and satellite-based products in particular should be more addressed in farmer education to ensure understanding and increase trust into the concept. Moreover, given a higher frequency of droughts, more farmers will be more adversely affected in future, which can further increase their PU. Insurers can therefore be advised to accelerate research and development of satellite-based index insurance because a large proportion of farmers perceive them at least potentially useful. However, our identified statistically significant factors need to be complemented by other factors to better understand farmers' PU. Therefore, the application of latent variables is recommended. For example, the effect of social factors, emotions or communication on insurance demand has not received sufficient research attention so far (Brown *et al.*, 2016; Jaspersen and Aseervatham, 2017). Hence, by integrating these factors as latent variables, their effect on PU could be brought to light. In addition, to corroborate the results, further research with greater consideration given to smaller farms and less educated farmers is recommended. While this study focused on a developed country, our results can be applied to a certain extent to developing countries, which also suffer from climate change. Given that many of these countries do not have a comparable network of weather stations, satellite-based index insurance could reduce basis risk considerably, which could increase the PU.

References

Brown, J.R., Kapteyn, A. and Mitchell, O.S. (2016), "Framing and claiming: How information-framing affects expected social security claiming behavior", Journal of Risk and Insurance, Vol. 83 No. 1, pp. 139–162, doi: 10.1111/j.1539-6975.2013.12004.x.

Clarke, D.J. (2016), "A Theory of Rational Demand for Index Insurance", American Economic Journal: Microeconomics, Vol. 8 No. 1, pp. 283–306, doi: 10.1257/mic.20140103.

Clement, K.Y., Wouter Botzen, W.J., Brouwer, R. and Aerts, J.C.J.H. (2018), "A global review of the impact of basis risk on the functioning of and demand for index insurance", International Journal of Disaster Risk Reduction, Vol. 28, pp. 845–853, doi: 10.1016/j.ijdrr.2018.01.001.

Grillakis, M.G. (2019), "Increase in severe and extreme soil moisture droughts for Europe under climate change", The Science of the Total Environment, Vol. 660, pp. 1245–1255, doi: 10.1016/j.scitotenv.2019.01.001.

Jaspersen, J.G. and Aseervatham, V. (2017), "The Influence of Affect on Heuristic Thinking in Insurance Demand: The Influence of Affect on Heuristic Thinking in Insurance Demand", Journal of Risk and Insurance, Vol. 84 No. 1, pp. 239–266, doi: 10.1111/jori.12088.

Pierpaoli, E., Carli, G., Pignatti, E. and Canavari, M. (2013), “Drivers of Precision Agriculture Technologies Adoption: A Literature Review”, Procedia Technology, Vol. 8, pp. 61–69, doi: 10.1016/j.protcy.2013.11.010.
Prochaska, J.O. and Velicer, W.F. (1997), “The Transtheoretical Model of Health Behavior Change”, American Journal of Health Promotion, Vol. 12 No. 1, pp. 38–48, doi: 10.4278/0890-1171-12.1.38.
Schmitt, J., Offermann, F., Söder, M., Frühauf, C. and Finger, R. (2022), “Extreme weather events cause significant crop yield losses at the farm level in German agriculture”, Food Policy, Vol. 112, p. 102359, doi: 10.1016/j.foodpol.2022.102359.
Vroege, W., Bucheli, J., Dalhaus, T., Hirschi, M. and Finger, R. (2021), “Insuring crops from space: the potential of satellite-retrieved soil moisture to reduce farmers’ drought risk exposure”, European Review of Agricultural Economics, Vol. 48 No. 2, pp. 266–314, doi: 10.1093/erae/jbab010.