CLIMATE CHANGE ADAPTATION OF AUSTRIAN FARMS

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Summary

Adaptation to climate change in agriculture is a key goal in order to mitigate its effects. The Ricardian method has been used extensively to account for adaptation within impact assessment. Yet, it follows the relatively strict assumption of farms being perfectly adapted to climate. Building on upcoming evidence of potential limitations of adaptation we relax this assumption and analyse climate change adaptation at the farm-level. Our findings overall depict imperfect adjustment to climate change of Austrian farms and therefore contradict the concept of perfect adaptation.

Keywords

Climate change, agriculture, adaptation, farm-level.

1 Introduction

Agriculture is highly influenced by climate change and thus specific measures to improve adaptation are applied (EEA, 2019). Hence, it is important to account for possible adaptation when assessing climate change impacts. In particular, a statistical method extensively used is the Ricardian approach, which follows the strict assumption of perfect adaptation to changing climate (MENDELSOHN ET AL., 1994). Yet, adaptation is a complex process, since it is influenced by various factors (SMIT AND WANDEL, 2006) and there is upcoming evidence that farms are not responding sufficiently to climate change (BURKE AND EMERICK, 2016) and thus perfect adaptation might not prevail. Therefore, this study accounts for potential limitations of climate change adaptation when analysing climate change impacts by relaxing the assumption of perfect adaptation and derives the extent of adaptation of Austrian farms.

2 Methods and Data

In the Ricardian approach farms are assumed to have adjusted production practices in the long-run to the climatic conditions they are facing in order to maximize their profits. Consequently, the expected long-run profits would depend only on the exogeneous variables climate and other controls (i.e. subsidies, soil). In contrast, we assume the ability of farms to adapt to a changing climate is limited. Various factors, such as lack of information, resources and/or technologies might hamper potential adaptation. Therefore, if the rate of adaptation of farms is slower than climate change, farms are lagging behind in their long-run adaptation. However, identification of (im)perfect adaptation is complex, since not only profits change with climate but adaptation too. Therefore, we follow the work of MOORE AND LOBELL (2014), who use the fact that expected annual short-run profits can differ from long-run profits due to unforeseeable annual weather anomalies. While farmers are assumed to slowly adjust to changing climatic conditions (long-run response), long-term adjustments are not possible for unforeseeable annual weather (short-run response). Consequently, we can use this fact to identify the climate change adaptation: In the case of perfect adaptation, unexpected deviations of annual weather from climate would always lead to diminishing profits (MENDELSOHN ET AL., 1994). However, if unexpected short-run weather deviations from climate result in higher profits than those attainable in the long-run, this indicates imperfect adaptation. To estimate this relationship, we extend an econometric model using panel data of MOORE AND LOBELL (2014), which relies on both, cross-sectional variation in climate and inter-annual variation in weather:

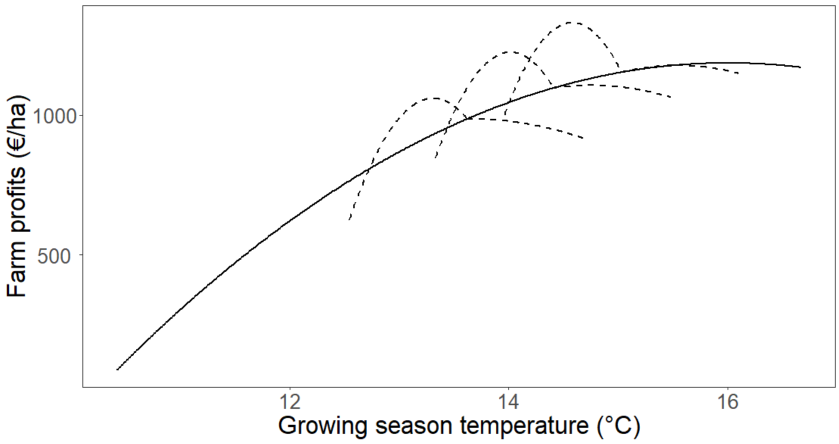
$$(1)\quad V_{it} = \overline{W_{it}}\beta_1 + \overline{W_{it}^2}\beta_2 + D_{it<0}\beta_3 + D^2_{it<0}\beta_4 + D_{it>0}\beta_5 + D^2_{it>0}\beta_6 + (\tau \times \overline{W_{it}})\beta_7 + \gamma X_{it} + \alpha_i + v_t + \varepsilon_{it},$$

where V_{it} are the short-run profits of farm i in year t. Meteorological variables are denoted by long-term climate $\overline{W_{it}}$, yearly weather deviations D_{it} and their quadratic forms, including growing season temperature and precipitation. $\overline{W_{it}}$ is a farm-specific 20-year moving average and captures the long-run effect of a changing climate on profits. D_{it} denotes differences between annual weather and climate. This component is split up, so that it captures impacts from e.g. warmer and cooler weather separately and thus helps to identify (im)perfect adaptation. To allow the short-run responses to vary with climate, we add interaction terms of climate and a vector of weather deviations τ. Finally, in order to control for (un)observed heterogeneity we introduce X_{it}, representing subsidies, as well as α_i and v_t, denoting farm- and time-fixed effects, respectively. Our calculations are based on FADN data of an unbalanced panel of 1,716 farms, located in arable regions of Austria between 2003 and 2016. To account for changes in prices we correct farm profits and subsidies using an agricultural price index from 'Statistics Austria'. Meteorological data are obtained from the Austrian governmental agency ZAMG at a resolution of 1x1 km^2.

3 Results and Outlook

The long-run response denotes how profits evolve with changing climate, when farmers are able to (partially) adapt (solid line in Fig. 1). The short-run responses allow us to separately capture the effects of positive and negative weather deviations from a given climate on profits (dashed lines in Fig. 1). In the case of cooler temperature than anticipated, the three depicted short-run responses lie clearly above the long-run response, denoting higher profits. This is in line with our expectations of a short-run optimum above the long-run response, indicating that farms are lacking adaptation. Consequently, the assumption of perfect adaptation does not hold, suggesting that (at least in our case study) the Ricardian method underestimates climate change adaptation of farms. As climate change is ongoing and temperatures will further increase, further development and implementation of effective adaptation measures is therefore crucial.

Figure 1. Relationship between farm profits and temperature.



Source: Own calculations.

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