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1 Introduction

This deliverable focuses on the assessment of efficiency and resilience at the farm level through a 'top-down approach', i.e. through analysing Farm Accountancy Data Network (FADN) data. The analysis includes 25 countries, a 13-year period (2004-2017) and 11 environmental zones, in total leading to more than 800,000 observations. (The 'top-down approach' contrasts with the so-called 'bottom-up approach' of MIXED in which farm and regional specific contextual issues are explored in 10 case studies, i.e. the MIXED networks.)

Open access paper
The top-down farm-level assessment has been submitted as a paper to a refereed open-access journal. Due to strict publication rules, this deliverable therefore presents an extended abstract (Section 2), instead of the full text and analysis. As soon as the paper has been published, the link to the full paper and supplementary materials will be made available.

Cross-validation of top-down and bottom-up results as part of regional-level analyses
Results from top-down analyses can be enriched through insights obtained from the MIXED bottom-up analyses. Due to aggregation of FADN to NUTS2 level, results from top-down analyses are to be interpreted for farms in their regional context. We therefore include the cross-validation of bottom-up and top-down analyses in the regional-level analyses (D6.3).

2 Extended abstract of submitted paper

The relationship between efficiency and resilience in European agriculture: a comparison between mixed and specialised farming practices in the FADN

Background

Efficiency and resilience are critical goals for the agricultural sector. However, efficiency and resilience are often perceived as conflicting objectives. This conflict comes from a resource allocation problem, where farmers are exposed to the quest of either concentrating efforts towards efficient production or building resilience via spare capacity, reserve stocks, and redundancy (Korhonen and Seager, 2008; Stanley, 2020). However, there might be synergies between efficiency and resilience, for instance, through improving soil health (Stevens, 2018) and adjusting crop rotations (Bowles et al., 2020).

Literature gap

The relationship between efficiency and resilience is an empirical question that has not been investigated so far. Efficiency defines the best possible ways of transforming inputs into outputs (Coelli et al., 2005); resilience informs whether a system can maintain the provision of products, services, and functions, whilst coping with stresses and challenges of different nature (Meuwissen et al., 2019). In agriculture, yields and economic indicators often support measures of resilience. These measures are intrinsically connected with production processes. However, few studies have explored resilience from a production theory perspective.

Research aim

Our research aim is to quantitatively explore the relationship between efficiency and resilience performances through a production theory framework. We explore the hypothesis (H1) that an "inverted-U" relationship between efficiency and resilience exists, where there is a positive correlation up to a point that this correlation becomes negative. Based on previous research indicating that specialisation can be an important source of trade-offs between aspects of efficiency and resilience (Abson, 2019; Klasen et al., 2016), we also discuss the hypothesis (H2) that mixed farms are more able to benefit from potential synergies between efficiency and resilience than the specialised counterparts.

Approach

Benchmarking and production theory are the two guiding concepts for measuring efficiency and resilience. While efficiency is often assessed using production theory, this has thus far not been done for resilience. Going beyond partial productivity and economic output analyses, we fully exploit the FADN dataset by defining production technologies for different environmental zones and agricultural outputs. Exploiting the properties of production functions, we calculate farm resilience as a composite indicator of robustness, adaptability, and transformability (Meuwissen et al., 2019). The benchmarking component involves comparing our observations to the best performers in both production efficiency and production resilience capacities. To test the hypothesis of an "inverted-U" relationship between efficiency and resilience, we estimate a quadratic equation using ordinary least squares.

Data

We extract farm-level inputs and outputs from the Farm Accountancy Data Network (FADN). We measure efficiency and resilience from a sample that contains of over 800,000 observations from 25 countries across 11 environmental zones, from 2004 to 2017. The production contexts are given by the environmental zones as proposed by Metzger et al. (2005). We classified the dominant environmental zone considering the agricultural related land uses as extracted from the CORINE land cover (CLC) maps of 2018 version v.2020_20u1 (EEA, 2020). The zones are presented at the NUTS 2 level, which is the finest scale in the FADN data set. Additionally, we consider the FAO's agriculture stress index (ASI) (FAO, 2022) as proxy for other weather-related aspects that relate to agricultural productivity (Magrini et al., 2018).

Results and policy recommendations

Contrary to our hypothesis (H1), we find a *non-inverted* U-shaped relationship between efficiency and resilience, where synergies appear at higher levels of efficiency. When taking a long-term perspective, the farmers' ability to maintain high levels of efficiency is directly related to their resilience. Our results highlight the potential for strategies that can enhance both efficiency and resilience simultaneously. When examining efficiency and resilience separately (H2), specialized practices are more efficient than mixed practices, while mixed practices are more resilient than specialized practices. Based on these results, policy efforts may focus on improving efficiency of mixed practices and resilience of specialized practices. However, we observe some variation across environmental zones in this regard. Thus, policy makers may need to tailor interventions to specific farming practices based on different environmental zones.

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