4.2 REPORT ON MODELLING STRUCTURAL CHANGE AND FARM INTERACTION ON LAND MARKETS AND INTERFACES WITH THE MIND STEP MODEL TOOLBOX (M36+4)

Background and key outcomes/messages towards policy makers

Drivers for structural change are manifold and include technology and productivity growth, farm-household and path dependency, input and output prices and macroeconomic conditions. A comprehensive theoretical framework accounting for the known drivers of structural adjustment in agriculture does not exist. However, in the field of econometric methods, there are applications of certain aspects of farm structural change, e.g., farm exit and growth, or applications that analyze structural change with a Markov transition probability model.

Recent progress in the availability of detailed individual farm data has broadened the potential for policy impact analysis on the strategic behavior of farmers. This Task conducts farm exit estimations for Germany (Section 2) and Norway for which single-farm data at census level are available (Section 3 and 4). The Norwegian case is considered because the available data include the geolocation of the farm address. This provides an interesting case to explore possibilities that can be transferred to EU members once such data is available there as well (in Germany farm location are currently available at a 5x5 km grid level). These new methods capture well non-linear relationships (including thresholds) and complex dynamics over time.

Further innovations compared to the literature on farm exit estimations are the systematic incorporation of spatial, farm interaction effects, specific regional characteristics as well as detailed georeferenced biophysical data (climate and soil, see WP2) capturing local production conditions. The new delineation approach is presented in Section 5.

In Section 2, an analysis to farm exit in the German agriculture was undertaken. A logit model was used to analyze the decision of farmers to exit the farming sector between 2010 and 2020 using data from the German Farm Structure Survey. The data set was augmented by systematic incorporation of spatial and farm interaction effects (Herfindahl-Hirschman-Index of agricultural land used – a proxy for the distribution agricultural land), specific regional characteristics (economic indicators at NUTS 3 regional level) as well as detailed georeferenced biophysical data (incorporation of soil-climate regions) capturing local production conditions. Results showed that farm-level variables, such as the farmer's age, agricultural land use, profitability, and farm type, had a greater impact on the exit decision compared to neighborhood and regional variables. The most predictive variable was the farmer's age. The results indicate that various factors contribute to the exit of farms from the agricultural sector and should be interpreted with caution, as they are observational and cannot establish causality.

Section 3 presents farm exit estimations in the broader framework of structural change analysis in Norway. This section examines the factors driving changes in the structure of Norwegian agriculture, using farm census data and a Multiplicative Competitive Interaction (MCI) model. The MCI framework was extended to account for absolute farm numbers and exit decisions, and to consider the effect of neighboring farms on farm structure. Results show that the relative importance of variables is similar to previous findings, but farm manager age and population density were not selected as significant variables. The

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extension to include the neighboring farms improved the explanatory power of the model, and simulations indicate that larger farm groups are expected to increase their share in 2025, while a declining farm density negatively impacts most farm groups. Limitations include the absence of farm income data and the effects of regional heterogeneity and other missing variables. The model's extension towards absolute farm numbers and exit groups can now be used for policy impact analysis using mathematical programming models.
In Section 4, the Agrispace model is applied to farm structure survey data in Norway. The EU (CAP) and Norway are using agricultural policies with different payment rates for production activities (i.e., number of animals and farmed area) and farms at the regional level, which creates challenges for agricultural sector models that assume uniform payment rates. This research investigates the impact of these farm-specific payment rates on supply and farm structure in Norway. Norway was selected as a case study due to its diverse agricultural policies with payment rates that vary by region and farm size. The simulation results indicate that the level of per unit payments for agricultural products within a region plays a significant role in shaping the supply of these products. This is because payment farm-specificity affects both the number of farms and the level of activity within a region. More research is required to understand the relationship between recipient characteristics and impact. The findings suggest that incorporating payment farm-specificity into agricultural sector models, such as the CAPRI model, which do not currently account for farm structure and structural change, will be important. This work will be carried out in the MIND-STEP subtask 5.2.3.
Section 5 presents the improvement of an existing land market model prototype of IFM-CAP. In land market research, various models are used to simulate land supply, allocation, and markets. These models range from abstract Computable General Equilibrium (CGE) models to more detailed Agent Based Models. CGE models use Constant-Elasticity of Transformation functions and some include land supply and transformation functions. Partial Equilibrium (PE) models use a CGE structure and CET functions. Non-economic land cover models use actual land cover maps and Spatial Land Cover Change models use transition probabilities. Agent Based Models combine spatial competition and land cover change algorithms. The IFM-CAP land market model incorporates elements of general and partial equilibrium models and is spatially scalable, allowing for more detailed farm location information to be used. The current land market model does not yet account for a new delineation. The implementation using the farm spatial unit (FSU) delineation for at least ten selected regions in Germany compatible with the farm exit estimations from section one will be conducted in WP Task 5.2.3. „Subtask 5.2.3 Structural change representation in current models". The target is to build cluster of FSU with similar homogenous factors for land and to account for the pressure on the land market from intensive animal production. The delineation will be based on a cluster of the presented for parameters on income per AWU in Euro, milk yield in tones per cow, stocking density in LU/ha and wheat yield in quintals/per in Germany. The cluster is then the new cell to run the IFM-CAP farm inside the cells which are located in the cluster together with the land market model.

Methodological developments

The MCI framework was transferred to the Norwegian case, which enabled to observe absolute farm numbers and exit decisions. Further, neighboring effects could be used in that framework.

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With respect to Agrispace, indicators were developed to quantify payment farm-specificity which denotes the level of per unit payments for agricultural products for farms specified in a model.

With respect to the improvement of an existing land market model prototype of IFM-CAP, cluster of FSU with similar homogenous factors for land was build and it was accounted for the pressure on the land market from intensive animal production.

Policy implications of obtained empirical results

For the analysis of German FSS, not too much implications for policy should be stated. Here, a probability prediction model was estimated to test these results in the context of farm optimization models. Even though, most of the estimated parameters showed expected signs, the results cannot be interpreted causally. Therefore, policy implications should not be derived from single parameters.

For the Norwegian case and the application of the MCI framework, most of the structural change of the farms can be explained by the past farm structures and, to a smaller extent, by factors such as subsidies, natural conditions, macro variables and prices. Farm structural changes are less dynamic. This leads also to relatively stable shares for certain farm groups, and hence a higher explanatory contribution from past farm structures in the model, even though the total farm number is declining.

The simulations in section 4 show that payment farm-specificity matters for the supply of agricultural products. That is, a change in payment farm-specificity results in a change in activity levels and the distribution of the activity level across farms. To the extent that payment farm-specificity becomes more important for CAP-design, policy simulation models should be further developed to take this aspect into account."

Data needs

For the analysis of German FSS data it shows, that especially income data would be very helpful for the analysis of structural change, especially exit decisions. As this is not part of the German FSS, only matching with other data bases on income could solve this problem. As far as we know this is not possible due to regulations. Further, the information about a possible successor is not surveyed for all farms, but only for a sample. As this is also an important information, it should be surveyed for all farms.

For the analysis of Norwegian FSS data, household income data would be very helpful for applying the MCI framework to analyze structural change. In Norway, this is possible under specific conditions. The authors did not go in this direction.

For payment farm-specificity, there are no further data needs as activity levels and payments for each activity are available at farm level.

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