Stochastic Frontier Analysis for Austrian Agriculture Productivity Analysis

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***Abstract* - Efficiency analysis is one of the major tools helping to improve economic productivity. In Austria the Data Envelope Analysis has been applied often in recent times, and also methods comparing similar farms with respect to some distinct criterion are implemented. The Stochastic Frontier Analysis could be another tool. It became more prominent in recent years in international literature, but has not been implemented for the Austrian agriculture. This paper first explains the principle differences of these three approaches to show the distinct character of the Stochastic Frontier Analysis. It then outlines some possibilities to use this method. Data from the Farm Accountancy Network are used to discuss examples.**

EFFICIENCY ANALYSIS

Efficient use of resources is very much at the heart of any economic reasoning. It is essential for the competitiveness of firms, for the justification of public spending e.g. on agricultural policy programs, and for a sustainable use of resources in general. Microeconomic theory offers a strong basis for this kind of analysis. Methods could closely build up on it, like the Data Envelope Analysis (DEA) following an optimisation approach (Hambrusch et al., 2006) or the Stochastic Frontier Analysis (SFA) relying on econometric evaluations. Other methods – namely matching - following similar intentions stay closer to descriptive evaluations (Coelli et al., 2005).

Each of these approaches has its advantages and drawbacks. The SFA has – to the knowledge of the authors – not yet been implemented in research on agriculture in Austrian. Considering the prominence of the SFA in the agricultural economics literature and its acceptance as quasi text-book standard it should be worthwhile to look at its conceptual distincition and its empirical usability.

Following Kumbhakar and Lovell (2000:1ff) the usual production, profit or cost functions as known from standard microeconomics textbooks are characterised by the assumption that firms optimise successfully. The fact, that individual firms are empirically not found exactly on an estimated function is then attributed solely to measurement errors or influences outside the reach of the firm (weather etc.). In this sense, the deviation of firms from estimated functions is assumed to show the typical normal distribution of statistical noise. SFA maintains the existence of normally distributed statistical noise but makes an additional assumption for differently distributed technical inefficiencies (e.g. half-normal distributed). Thereby, the analysis of production, cost, and profit is recast from traditional *functions* towards *frontiers.*

The differences between SFA and DEA then boil down essentially to two characteristics (Passel et al., 1996 or Kebede, 2001):

1. The SFA as an econometric approach attempts to distinguish noise from inefficiency. The DEA as programming approach is non-stochastic and lumps both effects together. It then calls the result inefficiency.
2. The SFA is parametric, and confounds the effects of misspecification with inefficiency. The DEA is non-parametric and less prone to this type of specification error.

The statistical problem of an appropriate identification of control and treatment groups is tackled by the *matching*approach, selecting data for farms which can be compared pairwise, showing differences only with respect to e.g. a particular policy instrument. This should help to limit the identification bias (Kirchweger et al., 2011). The advantage of the SFA could here be seen in its comprehensive – less cumbersome – approach, its disadvantage in its restriction to somefunctional specification and in the danger of the usual econometric fallacies like the mentioned identification problem.

It is obvious that each of these approaches can be most promising, justdepending on the research question addressed, when encountering different data availability, or different research backgrounds. SFA might also find a place in this context in Austria.

DATA FROM AUSTRIA

In principle, the data situation in Austria allows extensive econometric work. Bookkeeping data (as part of the European Farm Accountancy Data Network – FADN) are available now for seven years following the same consistent and detailed coding system. Earlier data are available as well, though showing different coding and conceptual features. Each year more than 2.000 sets of farm data can be evaluated. The data can pooled or combined to panel data. Fluctuation of farms requires decisions on whether or not tobalance panel data sets.

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This short paper limits itself first to bookkeeping data of the year 2005. In total there are 2.402 farm observations in this year. Farms with less than 1.000 € gross output/yearand one outliers are excluded.

Estimation Results of the Frontier[2]

An integral part of the estimation of the stochastic frontier is the specification of a production function. For this paper Cobb-Douglas and Translog production functions have been estimated. This was done for the overall set of data and for the selected sets of data.The explained variables were monetary or physical outputs; the explaining variables were land, labour, capital and intermediate inputs.

The general result was that – as expected– the Cobb-Douglas function did show very high levels of significance throughout, while the Translogproved problematic namely when the number of farms was restricted to e.g. crop farms only. The only way out will be to increase the number of years included in the set of data.

When going for efficiency estimates the advantage of higher levels of significance – achieved mainly due to a lower number of parameters of course – comes at a price: The SFA based on a Cobb-Douglas specification is far more restrictive than the Translog. It leaves all individual deviations from the estimated function to statistical noise. In fact, the SFA based on the Cobb-Douglas function reports a mean efficiency 0.99, i.e. hardly any inefficiency at all. The SFA based on the Translog – being more flexible – instead detects the respective value at 0.93.

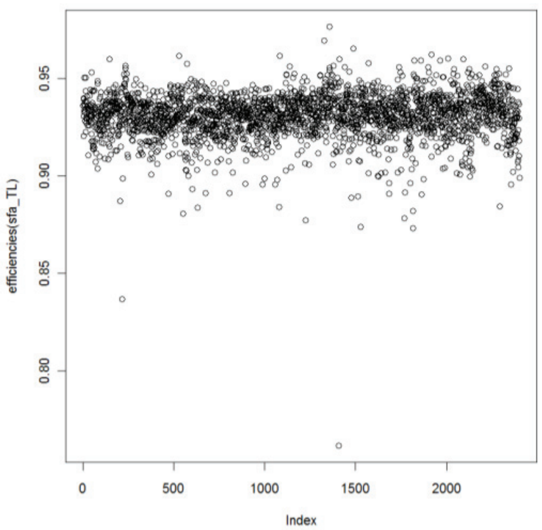

Figure 1.Degrees of efficiencies of 2.306 Austrian farms.

Possible Determinants of Inefficiencies

Of course, this whole exercise can only become relevant when it is possible to identify specific sources of the detected inefficiencies. For this paper possible determinants were introduced as additional variables: i) the sea level (being important Austria, where specific mountain farm payments are supposed to make up for disadvantages) ii) organic production (which is supported as well iii) part time farming.

Inefficiencies have now been estimated for gross output a) including and b) not including compensation payments. The estimation of the determinants of the inefficiencies could show that under a) there would be no, or no strong negative impact of the sea level or organic farming on efficiency. When estimating output not including compensation payments, the impact is of stronger and significant influence. In short: Efficiency analysis requires to include also rent seeking as production target. Part-time farming is reported to be a significant determinant of inefficiencies in any case.

Conclusions

The Stochastic Frontier Analysis (SFA) offers possibilities to extend efficiency and productivity analysis of Austrian farms. Its major advantage lies in its conceptual distinction betweenstatistical 'noise' and inefficiency. By recasting typical micro economic *functions* to *frontiers*, a failure to miss optimality is not just a matter of the typically assumed random distribution, but it is in part attributable to the sphere of influence of the farmer.

Still, SFA is to be implemented carefully. The principal possibility of offering strong empirical evidence is to be seen in the context of the selection of an appropriate specification, and the availability of sufficiently large data sets. The selection of variables can be as decisive as the selection of farm types. Reducing the heterogeneity by selecting specific farm types reduces the complexity of problems, but requires data sets covering more than – in the case of Austria – a single year of observations.

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[2]For evaluation and estimation 'R' was used, namely the package 'sfa'. (http://www.r-project.org/)