FACEPA

Farm Accountancy Cost Estimation and Policy Analysis of European Agriculture

Comparison of cost estimates based on different cost calculation methods and/or different data bases

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Executive Summary

Within the FACEPA project, considerable resources have been allocated to implement and validate the 'general cost of production model' (GECOM). The outcome of the related work is published in three connected reports. The first two reports describe the implementation, the validation and the results from the GECOM on the basis of national farm accountancy data networks (FADN) and the EU FADN, respectively. This report provides an overall synthesis and conclusions.

First, general aspects of model specification and estimation, e.g. the list of outputs and inputs, are shortly summarized. In general, the more detailed the list of outputs the more accurate is the specification of the model. On the other hand, a longer list of outputs increases the probability that estimated cost coefficients of some outputs will be less robust and precise. This trade-off needs to be considered in view of the specific data for which cost estimates are sought, and is thus a decision to be taken anew for each application. The decision on the list of inputs, specifically the treatment of marketable farm-grown intermediates and the inclusion of subsidies, and the resulting income indicator needs to be taken in view of the research question to be analyzed.

The implementation of a seemingly unrelated regression algorithm in the Software package SAS allows for a very fast and stable estimation of the GECOM. However, one issue which was observed by all partners was the frequent occurrence of negative cost coefficients. While often not statistically significant, these negative coefficients proved to be a major concern in the validation of the model. The assumption of a common Leontief technology underlying the production function of all farms clearly constitutes a strong constraint on the applicability. Some of these limitations can be offset by selecting farm samples with homogenous technologies, and therefore as far as possible, farm samples should be stratified according to applied technologies.

During the testing of the GECOM, it was repeatedly highlighted that even small and/or infrequent data errors can have a significant impact on estimated cost share coefficients. Their identification has proved to be a major challenge, despite extensive plausibility checks by national and EU authorities. For the applications within the FACEPA project, a multivariate methodology based on the Mahalanobi distance measure to eliminate the data errors was tested, which generally improved stability of results over time, however often excluded an undesirably large share of observations.

The validation process showed that to ensure a correct interpretation of results from other sources in relation to GECOM cost estimations, a very careful examination of these sources is needed with respect to the approach used, the definitions of costs and cost categories, the definition and calculation of imputed costs and the scope of the costs allocated. In general, the validation of the GECOM by comparing results to those of other studies as well as by a review of estimates by national experts highlights that the quality of estimates differs by country. Overall, level and trend of total costs of the main products wheat, milk and pigs were judged to be plausible. Generally, estimated cost for crop products were less robust and in several cases implausibly variable over time. In many countries, also the estimates of individual cost components were assessed to be realistic, especially of direct costs, while the values for overheads and depreciation were less reliable.

An emerging key issue for the dissemination of results from the GECOM was that existing national "conventions" for the definition and presentation of production costs differ from the ones used in the FACEPA project. Thus, when presenting results in a national context, appropriate care needs to be taken to thoroughly explain approach and definitions, and to reprocess cost estimates to match national conventions as far as possible.

In the subsequent section, the outcome of the comparison of cost estimates based on EU and national FADN is presented and discussed. Differences in production costs estimates based on EU vs. national FADNs may in principle be caused by differences in samples, weighting factors and data. The analysis showed that while in many cases production costs estimates based on EU and national FADN are very similar, in numerous instances results differ significantly. In these latter cases, results based on the national databases were generally judged to be more plausible. This outcome is in line with prior expectations, as data in national FADNs are by nature more differentiated and closer to 'original' farm data, and national weights better reflect the actual sampling procedure than this can be the case for the weights derived by the static EU FADN weighting system.

Based on the experiences made with the GECOM application above, this report emphasizes that the generic software tool for implementing the GECOM should offer user-friendly options for carrying out basic data pre-checks, provide flexibility with respect to selection of samples and aggregation of outputs and inputs, and produce a clearly represented overview of the statistical significance of estimated coefficients.

As a general conclusion, the implementation, testing and validation of the GECOM showed that the model can provide plausible estimates of production costs for main products in most countries, reflecting developments over time as well as cost composition, while results for products with smaller output shares were often not convincing and highly variable over time. However, the experiences also showed the indispensable necessity of pre-checking the data in each case, dealing with outliers and taking into account details and changes in the data definition and collection. A general conclusions from the experiences gained is that no "simple" application of one general model is possible for all samples and products. An analysis and validation of results by experts (i.e. of both FADN data and agricultural production systems in the analysed samples) will always be needed.

Key issues for future research concerning the GECOM are the estimation of production costs for meat products, and the search for improved, robust and transparent outlier detection methods. Other estimation approaches (e.g. panel and entropy estimators) and/or model specifications (flexible functional forms) have an obvious potential for dealing with several of the limitations of the current methodology identified in this report, however, more research is required to facilitate a broader and more robust application of these approaches to estimate production costs for all EU Member States.

Contents

Abbreviations and Acronyms

FADN	Farm accountancy data network
FNVA	Farm net value added
GECOM	General cost of production model
OLS	Ordinary least squares
SFP	Single Farm Payment
SUR	Seemingly unrelated regression

1 Introduction

Within the FACEPA project, considerable resources have been allocated to implement and validate the 'general cost of production model' (GECOM). The outcome of the related work is published in three connected reports. The first two reports (Offermann, 2011; Kleinhanss, 2011) describe the implementation, the validation and the results from the GECOM on the basis of national farm accountancy data networks (FADN) and the EU FADN, respectively. This report provides an overall synthesis and conclusions.

To allow a broad and at the same time harmonized approach to the testing and validation of the GECOM model, a common SAS software tool as well as accompanying guidelines were developed. All project partners carried out analyses for their own countries, based on either national and/or EU FADN data, and held workshops with national experts. This report provides the corresponding synthesis of experts' feedback and partners' experiences with model estimation, and seeks to highlight the lessons learned. With respect to future applications of the GECOM model and its further development, this report aims to

- provide some guidelines for its future application to FADNs
- provide recommendations for the design of the software tool developed in work package 4
- identify future research areas

This synthesis report is structured as follows: First, general aspects of model specification and estimation, e.g. the list of outputs and inputs, are shortly summarized. The next sections discusses issues of data quality identified during the testing of the GECOM as well as strategies to deal with related challenges, e.g. sampling and outlier elimination. This is followed by a synthesis of the results from the validation of the GECOM by comparing results to those of other studies as well as by a review of estimates by national experts. Based on the experiences gained during this process, recommendations for the presentation of GECOM results are derived. In the subsequent section, the outcome of the comparison of cost estimates based on EU and national FADN is presented and discussed. The report concludes with some recommendations for the design of a generic software tool for implementing the GECOM, and the identification of key issues for future research.

2 Synthesis of model implementation and validation

2.1 Model specification and estimation

The conceptual framework, econometric specifications and estimations procedure for the GECOM are described and discussed in detail in Surry et al. (forthcoming). Here, we focus on the experiences made by partners during the implementation and testing of the model, and the resulting conclusions and recommendations.

The concrete specification of the model requires decisions on the list of outputs, the list of inputs, the treatment of subsidies, and, interlinked with the outcome of the decisions, the definition of the income indicator.

The definition of the **list of outputs** is mainly determined by data availability:

- For the application of the GECOM, in general partners kept the rather detailed output list defined on the basis of the variety of products produced in the EU-27.
- In general, the more detailed the list of outputs the more accurate is the specification of the model.[1] On the other hand, a longer list of outputs increases the probability that, firstly, only few observations exist for a specific output, and secondly, serious multi-collinearity between some outputs arises. In both cases, the estimated cost coefficients of respective outputs will be less robust and precise. This trade-off needs to be considered in view of the specific data for which cost estimates are sought, and is thus a decision to be taken anew for each application.
- For meat production, the use of EU FADN involves a general problem: as the data includes no information on the physical quantity of the "end product" (i.e. ton of meat), but only information on the number of live animals sold (without information on the weight of these animals, and no definite information on whether these are sold for further breeding, fattening or slaughtering), validation of results is difficult and comparability between farm samples or between countries limited. The use of external meat prices to calculate weights is not always a solution to this problem. Prices from other sources as, e.g., Eurostat, may differ from real farm gate live weight prices (Dolman et al., 2011), and may not fully reflect the price differences existing between farms and within an animal category (e.g. meat from cows; heifers; bulls, etc.). Especially for beef production, no comprehensive production cost could be generated by the GECOM. Continuing the work of Berner et al. (2011) on identifying samples with specific beef production technologies (e.g., suckler cow systems vs. intensive bull fattening) and extending the model accordingly, and utilising national FADN systems with recording of more physical output values, are thus a promising area for future research.

The definition of the **list of inputs** is also driven by data availability, consideration of which cost categories are of interest, and the definition of the income indicator:

[1] An example is the differentiation of barley into 'winter barley' (mostly used for feed) and 'summer barley' (mostly used for brewing), which is possible with the German national FADN. Compared to the estimation with one aggregated product, differentiated estimation significantly improves results.

- An allocation of some overheads and fixed costs to products is by definition problematic, and including these in the list of inputs may not give robust results for the respective coefficients. Including all accounting costs with the exception of costs of labour, land and capital in the model specification has the advantage that the resulting income indicator is close to the definition of "farm net value added" (FNVA) in the EU FADN. Including wages, rent and interest paid will however better reflect the real income situation of family farmers. Furthermore, the German case study (Berner et al., 2011) showed that it is also possible to additionally include imputed costs for family-owned factors, and thus estimate full costs. The decision on the list of inputs and the resulting income indicator should thus be taken in view of the research question to be analysed.
- Subsidies influence farm income. The information available in the farm accounts often does not allow the direct allocation of subsidies to specific products, even if the subsidies are (partially) coupled. Including subsidies as a (negative) input in the model specification thus provides the opportunity to derive product-specific subsidy shares. Generally, within the FACEPA applications of the GECOM model all coupled first pillar payments (e.g., the area-based direct payment for the Grandes Cultures) were included in the model specification, as well as most second-pillar payments. The decoupled Single Farm Payment (SFP) was not included, as it is fully decoupled, and an allocation to products therefore problematic. However, it should be borne in mind that the SFP is relevant for farm income and is accounted for in the calculation of the FNVA in the EU FADN. An inclusion of all subsidies including the SFP may be advisable for a correct interpretation of profitability of specific products, especially if land costs are included in the list of inputs.
- A specific problem is related to the question of how to deal with the on-farm use of marketable farm production (e.g., cereals for feeding). For the estimation of actual production costs for livestock products, it would be better to exclude the production used on farms in the list of inputs and outputs. For the assessment of 'economic' production costs and a broader estimation of costs for crop production, it is preferable to include marketable farm-grown intermediates in the list of inputs and include their market value in the respective outputs.

The assumption of a common Leontief technology underlying the production function of all farms clearly constitutes a strong constraint on applicability. Some of these limitations can be offset by selecting farm samples with homogenous technologies. Results from Berner et al. (2011) indicate that, given a basic knowledge of the technological structure of agricultural production in a country, it is possible to delimitate samples, e.g. by farm size classes, corresponding to changes in typical applied technologies, giving robust and plausible cost coefficient estimates for both crop and livestock products.

The chosen estimation method for the GECOM is the seemingly unrelated regression (SUR) approach. The implementation in the SAS environment allows for a very fast and stable estimation. Compared to an ordinary least squares (OLS) estimation of the individual input equations, the SUR approach has the advantage of ensuring that the overall budget constraint holds, i.e. the estimated coefficients sum up to one. However, one issue which was observed by all partners was the frequent occurrence of negative cost coefficients, which were judged to be implausible. While often not statistically significant, these

negative coefficients proved to be a major concern in the validation of the model, especially in the communication with external target groups. Multicollinearity was seen as one potential explanation of unstable coefficients especially for some crop products, however no solution to this issue was identified within the project.

The broader implementation of a generalised entropy estimator as an alternative to the OLS-SUR approach was hindered by the fact that up to now the SAS package includes only an experimental version of this approach, which in addition was not applicable for the GECOM model to larger (n>99) samples. With the given project resources, entropy estimators could be tested only for a case study of German farms from one region (Berner et. al, 2011). To this end, the entropy-SUR specification was formulated in GAMS and solved with Conopt. The results confirm the potential of entropy estimators for avoiding negative input coefficients, as well as the potential of cross-entropy formulation for including additional a-priori information on cost coefficients. However, the application also highlights the considerable influence that choice of number and level support points and distribution of a-priori probabilities have on results. More research is required to facilitate a broader and robust application of the cross-entropy estimation of production costs.

2.2 Data issues

2.2.1 Data quality

Aspects of data and quality issues of EU FADN with respect to production cost estimations have been discussed extensively in Delame and Butault (2009) and Hansen et al. (2009). Here, we report additional issues and challenges incurred when applying the GECOM.

During the testing of the GECOM, it was repeatedly highlighted that even small and/or infrequent data errors can have a significant impact on estimated cost share coefficients. These data errors may originate at different levels (e.g. during data collection; during data consolidation; in some case during transformation of national FADN to EU FADN). Their identification has proven to be a major challenge, despite extensive plausibility checks by national and EU authorities, and the application of an automated statistical outlier detection routine (see chapter 2.2.2).

Generally, the quality of farm accounts is very variable, which was also highlighted by national experts involved in the data collection. Especially the information on labour / working time in FADN was assessed to be rather unreliable in some countries. In addition, notwithstanding the efforts made for a harmonization of data within the EU FADN, national peculiarities to data specifications can impede the comparability of cost estimates across countries, and need to be taken into account for interpretation. Specifically, not-fully documented changes in the definition of variables may lead to unexpected breaks in development of costs over time (e.g., the general rules for depreciation in the Netherlands, specifically for milk quota, changed significantly during the period analysed in the FACEPA project. The reorganisation of the FADN sample of Italy from an ad-hoc towards random selection is another example.). In some countries, for the interpretation it is important to keep in mind that the main purpose of the farm accounts is for tax reasons; an adjustment of the accounts to receive a true farm economic account would be desirable but may not be feasible for all FADN data. The quality of estimates may also be inhibited in countries where, due to the specific definition a farm accounting year, expenses and

revenues for crop products in the accounting data may not relate to the same production period (e.g., Germany).

2.2.2 Sampling and Outliers

The estimation model assumes that all farms use the same technology. It is therefore important to delimitate samples such that they are as homogenous as possible with respect to the technology used. Commonly, farms with organic production systems should thus be estimated separately from other farming systems. The case studies (e.g., Berner et al., 2011) also highlighted the strong impact farm size has on the level and composition of production costs, and thus farm size[2] classes may in many cases be a good indicator to stratify for applied technology. Production cost estimates by farm size proved to be very plausible and in addition more stable to the influence of outliers than estimates based on the total sample. However, the possibilities for successful sample delimitation depend on suitable indictors for farms' technology, and may be limited by the number of sample farms available.

The elimination of an excessive impact of outliers on production costs results emerged as an issue of specific concern during the testing of the GECOM. Outliers are observations which appear to be inconsistent with the remainder of the data set or which have an unusually large or small value when compared with others in the data set, which could be due to observations having different characteristics regarding a specific variable, or due to measurement errors. Outliers may lead to model misspecification, biased parameter estimation and incorrect results. While many methods have been proposed for univariate outlier detection, the challenge of outlier detection for the GECOM lies in the strong interdependency of variables, which requires a multivariate approach. For the application within the FACEPA project, a multivariate methodology based on the Mahalanobi distance measure was tested (Bahta et al., 2011). This approach generally improved stability of results over time. However, often a rather large share of observations was excluded as outliers, which was seen as undesirable. Also, no clear pattern of which farms were identified as 'outliers' could be discerned, raising doubts with respect to the 'black box' mechanism underlying results. Further research in the direction of outlier detection methods which do not have the drawbacks seems worthwhile, as estimation results proved to be highly sensitive to even small and/or infrequent data errors.

2.3 Validation

2.3.1 Comparison to other sources of production costs

2.3.1.1 Limitations to comparisons: Data and definitional issues

Availability of other sources on production costs was a problem in many countries, and in general, it is easier to find information on specific cost items, while few studies were available that allocate overhead by activity or product. Data availability is better for milk

[2] The farm size indicator may differ depending on the sample/product analyzed. In the German case study (Berner et al., 2011), the size of arable area (for production costs of wheat), and the number of dairy cows (for production costs of milk), proved to indicators well suited to capture differences in applied technology.

and pigs[3] (due to the fact that for these products, it is often easier to identify strongly specialised farms), while very few studies exist which provide production costs for individual arable crop products.

Quite generally, the comparison of the FACEPA estimates of production costs to those of other studies was severely impeded by numerous differences in data and definitions:

- Other studies were often based on different samples than the FACEPA estimates (e.g., specific regions; farm types, farm sizes; periods; etc.), impeding an exact comparison.
- Cost aggregations often differed from FACEPA definitions, and in many cases the available data did not allow to disaggregate the results from other studies to make them comparable.
- Cost definitions differed, ranging from differences in terminology to differences in the treatment of costs. For example, many studies include "animal replacement" as a cost category, while the GECOM application used a net output approach to livestock production. Another common discrepancy is related to the specification of fodder costs: The GECOM model allocates the costs of fodder production to the list of costs categories (e.g., seed; energy; machinery), not all of which can be attributed to fodder production alone but may also include cost for livestock rearing and products (e.g. milking equipment). Other studies often report fodder costs as a single cost item, based on (imputed) market values or (elsewhere) calculated (full) production costs.
- Output definitions may differ. A common observation was that other studies providing "production costs per t of milk" often actually report the costs for the production not only of milk, but also implicitly a proportionate part of calf and old-cow output, whereas the GECOM treats these as different outputs and allocates the costs accordingly.
- Studies relying on planning data or expert assessments often (implicitly) refer to a different production technology than the observed average technology estimated by the GECOM.

Thus, to ensure a correct interpretation of results from other sources in relation to FACEPA cost estimations, a very careful examination of these sources is needed with respect to the approach used, the definitions of costs and cost categories, the definition and calculation of imputed costs and the scope of the costs allocated. Without a clear understanding of these issues, a real danger of comparing apples and oranges exists.

2.3.2.1 Results of the comparison

Comparisons of GECOM estimates to results from other sources were available for Germany, France, Bulgaria, Italy, The Netherlands, Estonia and Hungary. Generally, data availability was a major constraint, and the validation of the GECOM model by comparison to results from other sources was limited to selected products and periods.

[3] However, there is the need to distinguish between pig rearing and pig breeding when comparing estimates for the GECOM output 'pig'.

- The GECOM estimates for wheat and milk based on the German national FADN proved to be very similar to those from other studies, even on the level of individual cost categories.
- For France, the GECOM results showed a high similarity to those of technical surveys for wheat and corn, also closely reflecting variations and trends over time for individual inputs. For cow milk and fattening pigs, the level of estimated feeding costs as well as total variable costs, is very similar to that reported by the surveys, and closely follows the same trend over time. For overheads and fixed costs, the results depend strongly on the model specification and are closest to the survey results for the GECOM model without explicit estimation of home-grown feed costs.
- In contrast, for the Bulgarian data the estimated costs of milk production were significantly higher than results from a survey of dairy farms.
- For Italy, the GECOM results for wheat and maize were similar to those of other studies, with a comparable differentiation of total costs between North, Centre and South of Italy (only for maize, GECOM results for the South were too high). Concerning the contribution of individual cost items, it seems that for the analysed crop products, the share of depreciation in total costs is too high in the GECOM estimates.
- For the Estonian data, the GECOM results for total costs for wheat and milk were quite similar - though in general a bit lower - compared to those from other calculations. However, the GECOM model did not provide stable results for many individual cost items, and did not provide reliable costs for minor activities or for small samples.
- For Hungary, the estimated total as well as direct production costs for wheat, maize, sunflower and milk are similar to results from national data collection, while GECOM estimates for rape seed were not stable. For pigs, large differences in estimates and national data were observed, which might be related to different definitions of pig livestock units.
- Comparing GECOM estimates for the Netherlands with computed costs based on the same data but using a budgeting approach shows that for milk, total variable costs as well as other input costs and depreciation were rather similar, especially for specialised dairy farms. However, when using the total farm sample, the GECOM estimates for purchased feed proved to be significantly lower than the results from the calculations used for comparison. For pig production, estimated average results as well as trends were very similar for all aggregated cost categories, especially if farms with specialized piglet rearing were excluded from the sample. For wheat, average results of costs for seed, fertiliser and crop protection were comparable to those from the national FADN survey, especially if farms with starch potatoes were excluded from the estimation. However, results were not always plausible for individual years. For sugar beet, the GECOM model was not performing consistently.

2.3.2 Validation by experts

National workshops were held in Germany, Italy, Belgium, The Netherlands and Estonia to discuss the GECOM results with experts. The objectives were to supplement the often very low number of existing studies, to provide an opportunity to validate the GECOM in more detail, to identify causes of differences, and to derive recommendations for the further development of the GECOM and for the presentation of results from users of production cost calculations.

In many of these workshops, one key issue was that existing national "conventions" for the definition and presentation of production costs differed from the ones used in the FACEPA project. These differences were the cause of many misunderstandings and often a major problem for the successful communication and validation of the GECOM results. While on the one hand the use of a General Cost of Production Model, and the reliance on EU FADN terminology, ensure harmonised results which are comparable across countries, on the other hand the usefulness of these results for national stakeholders may be reduced. Thus, when presenting results in a national context, appropriate care needs to be taken to thoroughly explain the approach and the definitions used, and to reprocess cost estimates to match national conventions as far as possible.

Despite these limitations, the experts generally found the workshop very fruitful and in many cases expressed great interest in being informed on the progress of the project and maybe even having a follow-up workshop concerning results from an improved cost estimation model. Many helpful comments and suggestions were given with respect to the presentation of results. These have been taken up it the project and contributed to the recommendations summarised in Chapter 2.3.3. With respect to the validation of the GECOM by the national experts, the following conclusions can be summarized for the case studies:

- The general trend over time of estimated production costs for wheat, pigs and milk in Germany was judged to be plausible. Relative as well as absolute values of the specific cost categories seemed realistic, while the differences between farm groups with respect to the cost category 'other costs' were not seen as convincing. Results for oilseed and sugar beet production were assessed to be implausible on the basis of the large variations for depreciation and subsidies in different years. Experts pointed out that for more recent years, the production of energy maize (used for biogas production) was not properly taken into account and may distort results in some regions of Germany. They stressed the fact that results on pig production are not representative, as the FADN includes few large pig farms and no commercial (i.e. 'non-agricultural') farms, which are important for pig production in Germany.
- In the Netherlands, experts emphasized that generally results were better when differentiating samples to take into account different production systems, e.g. the differences in cattle production on specialised dairy vs. other farms, the differences in the product 'pig' in pig rearing and pig fattening farms, and the specificities on farms with starch potato production. Production cost for cattle were not seen as convincing, as the GECOM seemed to allocate too few feed costs to this product. Experts also stressed the fact that the value for cattle output is affected the valuation of animals by 'fair value' since 2001. They also pointed to the

intensification that took place in pig production over time and the effects this could have on production cost.

- Discussion with experts in Belgium confirmed the plausibility of the estimates for the two Belgian regions. While an overall cost of production estimate for pork was deemed useful by the experts, providing similar results for the farrowing sows or for the piglet sub-sectors would have been interesting in their own way and contributed to a more complete picture. In terms of robustness of the estimates, the picture has been less clear, and while most of the estimated coefficients are statistically significant, this was not true for particular cost item or commodities.
- In general, experts found most of the results for Italy to be reasonable, also for particular cases and with respect to the regional differentiation made. An exception was milk, for which the estimated costs were assessed to be lower than in reality. The trend of estimated production costs for the selected sectors was also judged to be plausible. The experts emphasized the need to separate the North from the South and also to take into account the altitude for estimating production costs in Italy, to account for the existing great differences in technology and practices.
- For Estonia, the differences between GECOM estimates for total costs for wheat, pig and milk and expert opinions were relatively low, while those for cattle and rapeseed were not seen as plausible. Generally, variations of individual costs coefficients were often seen as implausibly high, and the occurrence of negative coefficients were identified as a major challenge, requiring further model development.

2.3.3 Implications for presentation of results

Based on discussions among project partners, the feedback from experts during national workshops, and the experiences made during presentations to different scientific and administrative groups, the following recommendations for the presentation of GECOM results on costs of production emerged:

- Due to the many different definitions and understandings of the term ‘production costs’, a clear description of costs and subsidies included in the GECOM, as well as a definition of the resulting income indicator should precede presentations.
- All graphs should be fully self-explaining, including a clear definition of costs included or excluded. Information on the sample used and the sample size of all groups shown as well as their yield levels should be included.
- Statistical significance of estimated coefficients should be visually highlighted to assist interpretation.
- Additional full cost calculations can help to provide a more comprehensive picture of the cost situation at farm level. However, the part of the results which is based on imputed costs should be clearly separated from the estimated results.
- For comparing production costs between countries or different samples, production costs should be expressed as costs per ton.
- For time series of production costs of crop products, it is in most cases advisable to show the development of costs per hectare, as yearly variations per ton are mostly due to yield fluctuations.

- Averaging results from subsequent years in many cases increases robustness of results and facilitates identification of differences in level and composition of production costs between different samples or time periods, especially in countries with smaller farm samples.

2.4 Comparison of cost estimates based on EU and national FADN

Although the FADN datasets at Member States and EU levels are to a certain extent harmonised, differences occur (Delame and Butault, 2009). Differences in production costs estimates based on EU vs. national FADNs may in principle be caused by

- (systematic) differences in national and EU FADN samples
- different weighting factors
- differences in the data and/or aggregation of accounting to model variables

One specific objective of work package 3 of the FACEPA project was to analyse to what extent these differences effect GECOM results. Case studies were carried out using EU and national FADNs for Germany, The Netherlands, Italy and France.

A comparison between the results using the EU FADN and the German FADN highlighted significant differences. Overall, when using the German-FADN the results show slightly fewer negative values and fewer 'implausible values'. The differences in samples and weights seem to explain only few of the observed differences in the cost estimates, while the impact of data differences on estimated costs is rather large for some products.

While generally results for the two databases were very similar in Italy, for single years statistically significant differences in total costs as well as individual cost coefficients were observed for many products. In these cases, results based on the national FADN seemed much more plausible. Especially the values obtained for subsidies were in some cases very different, which may be due to a different aggregation of accounting variables in the two datasets.

A comparison of GECOM results for the Dutch data showed that for both milk and pigs, the effects of differences in the samples as well as of differences in data on cost estimations are small, while differences in the weighting scheme lead to larger differences in some aggregated cost categories. For total production costs however, differences are small. For wheat, differences between the different model specifications are quite large; however the quality of production cost estimates for wheat was judged to be poor in both cases. A detailed comparison of the data in the two databases confirms the results for the cost estimations, indicating that the different weights are the main cause for the observed dissimilarities.

In the French case, estimated costs of wheat and corn were very similar for both databases, though for some inputs less variable over time when based on the EU FADN. Especially for fertilizer and depreciation costs, the two model estimates are highly correlated. For pigs, the differences between the two model estimates were a bit larger.

Summarizing, the analysis showed that while in many cases production costs estimates based on EU and national FADN are very similar, in numerous instances results differ significantly. In these latter cases, results based on the national databases were generally

judged to be more plausible. This outcome is in line with prior expectations, as data in national FADNs are by nature more differentiated and closer to ‘original’ farm data, and national weights better reflect the actual sampling procedure than this can be the case for the weights derived by the static EU FADN weighting system.

3 Conclusions

3.1 Implications for software tool

Based on the experiences made with GECOM application reported above, the following recommendations can be made for the design of the software tool:

With respect to data preparation and model specification, the software tool should offer user-friendly options for

- carrying out a basic data pre-check, including information on sample sizes, number of observations for single products, minimum and maximum values of model variables
- allowing a flexible selection of samples
- allowing flexible aggregation of outputs and inputs
- automatically considering the consistency between input and output including subsidies and income.

As far as efficient entropy estimators are available in SAS, it could be of interest to a complementary use of both methods with a preference of the entropy approach for small sample sizes.

The software output should include

- an automatic warning of estimation problems
- a clearly represented overview of the statistical significance of estimated coefficients
- a clear differentiation between 'real' cost figures expressed in the FADN data and imputed costs of some fixed factors.

3.2 Conclusions and research outlook

The implementation, testing and validation of the GECOM showed that the model can provide plausible estimates of production costs for main products in most countries, reflecting developments over time as well as cost composition, while results for products with smaller output shares were often not convincing and highly variable over time. For the main products, in many cases, results also highlighted interesting and convincing differences in production costs between farm samples with different characteristics (e.g. size). However, the experiences also showed the indispensable necessity of pre-checking the data in each case, dealing with outliers and taking into account details and changes in the data definition and collection. As far as possible, farm samples should be stratified according to applied technologies. For the presentation of results, it often proved advisable to use multi-year averages instead of one year, especially for Member States with small samples. For too small samples, the SUR estimation does not give reliable results.

A general conclusions from the experiences gained, however, is that no "simple" application of one general model is possible for all samples and products. An analysis and validation of results by experts (i.e. of both FADN data and agricultural production systems in the analysed samples) will always be needed.

The testing of the GECOM confirmed that the estimation of production costs for meat products based on FADN remains a challenge, due to firstly, the lack of information on physical output values (weights) for livestock production in most FADN systems, and secondly due to the fact that the related production systems are highly heterogeneous and the FADN data does not allow for easy identification of the system applied by an individual farm. Extending the work of Berner et al. (2011) on identifying samples with specific livestock production technologies (e.g., suckler cow systems vs. intensive bull fattening) and, and utilizing national FADN systems with recording of more physical output values, are thus a promising area for future research. Another key issue identified for further research is the search for improved, robust and transparent outlier detection methods, as estimation results proved to be highly sensitive to even small and/or infrequent data errors.

Other estimation approaches like quantile regression, panel estimation models or entropy estimators have an obvious potential for dealing with several of the limitations of the OLS-SUR identified in this report, and extending the model specification to allow for a flexible functional form of the cost function could deal with the constraints imposed by the Leontief technology underlying the current GECOM specification. First case studies in these directions have been carried out within the FACEPA project (Desbois et al., 2009; De Blander and Henry de Frahan, 2010; Berner et al., 2011). However, more research is required to facilitate a broader and more robust application of these approaches to estimate production costs for all EU Member States.

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