Productivity, efficiency and technological change in French agriculture during 2002-2014: A Färe-Primont index decomposition

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Issue

The objective of the article is to assess productivity change in French agriculture during 2002-2014, namely total factor productivity (TFP) change and its components technological change and efficiency change.

On recent period, existing studies on this topic report contradictory results. For numerous years, most of the papers dedicated to TFP change analysis have used the classic Malmquist measures of TFP. By contrast, in this paper we use the Färe-Primont index (O'Donnell, 2011) to compute TFP and its components, based on non-parametric Data Envelopment Analysis (DEA) (Charnes et al., 1978). Productivity measures of a decision making unit (DMU) that can be expressed as the ratio of an output quantity change index on an input quantity change index, can be referred to as 'multiplicatively complete' (O'Donnell, 2008). Indeed, the Färe-Primont index verifies the multiplicatively completeness property and is also transitive, allowing for multi-temporal/lateral comparisons. This paper applies for the first time to French micro-economic farm data the more rigorous Färe-Primont TFP index. Moreover, we extend the Färe-Primont to the meta-frontier framework in order to compare the technology gap change between different types of farming,.

Framework and data

Six types of farming (i.e. main farm specialisations) are considered here: field crop farms; dairy farms; beef cattle farms; pig farms and poultry farms; mixed crop and livestock farms; and sheep farms and goat farms. TFP will firstly be assessed for each type of farming, that is to say with respect to their own frontier. Secondly, TFP will be assessed with respect to a common frontier, namely a meta-frontier (Battese et al., 2004, O'Donnell et al., 2008). Comparing the results obtained with respect to the separate frontiers and those with respect to the meta-frontier, will enable computing technology gap ratios that can show the most productive types of farming. To the best of our knowledge, this is the first extension of the transitive Färe-Primont index to the meta-frontier framework in light of O'Donnell and Fallah-Fini (2011).

Using data for farms that are representative of French agriculture, we aim at assessing whether the TFP has decreased or not during 2002-2014 and at shedding light on the sources of TFP change: technological change and efficiency change, the latter including technical, mix, scale and residual efficiency changes. This period of 13 years allows capturing the 2006 implementation of the decoupled Single Farm Payment (SFP) of the European Union's (EU) Common Agricultural Policy (CAP), following the 2003 CAP Luxemburg reform.

We use farm-level data from the French Farm Accountancy Data Network (FADN) database. This database includes yearly accountancy data (along with some technical and economic information) for around 7,000 professional French farms with an annual rotating rate of about 10% making the sample used an unbalanced panel data sample during the period considered here, 2002-2014. The FADN database is representative of professional farms which have a total standard output above a given threshold (25,000 Euros for France) to be considered as commercial farms.

The data are collected using a stratification based on the region where the farms are located, their economic size and their type of farming. Types of farming are defined in terms of the relative importance of the different productions on the farm in terms of total standard output. If, for instance, the dairy enterprise's standard output of a given farm accounts for more than two-third of farm's total standard output, then this given far is classified as specialist dairy. Besides, each farm is assigned a specific weight that captures the farm's representativeness.

For the analysis, four inputs are used: the farm utilised agricultural area (UAA) (in hectares), the labour force (expressed in full time equivalent units, the annual working units – AWU), intermediate consumption (in constant Euros) and capital (in constant Euros). For comparison purpose (and also for an easy implementation of meta-frontier approach) only one output is used: the value of the farm total output.

The French FADN data were accessed through the national centre for distant and secured access to data ('Centre d'accès sécurisé aux données' – CASD) maintained by the French statistical office (INSEE). In this frame, this work is supported by a public grant overseen by the French National Research Agency (ANR) as part of the 'Investissements d'avenir' program (reference: ANR-10-EQPX-17 – Centre d'accès sécurisé aux données – CASD).

Results and discussion

Results indicated that during 2002-2014, all farms had a TFP progress. Pig/poultry farms had the lowest TFP increase (4.5%) while beef farms had the highest (19.1%). The latter had the strongest increase in efficiency change (21.8%), suggesting that for these farms technological progress was rather existent in the 1990es due to the introduction of advanced technologies such as feed distribution equipment. In the 2000es beef farmers managed to

adjust their practices to the new technology and became highly efficient. Pig/poultry farms had the least changes in technical efficiency during the period. As shown by the review by Minviel and Latruffe (2016), the technical efficiency of farms in the EU is influenced by the CAP subsidies, the influence depending on the type of subsidies. Latruffe et al. (2016) also showed that the effect of CAP subsidies on EU dairy farms was diminished after the introduction of the decoupled Single Farm Payments. The fact that technical efficiency for pig/poultry farms is relatively stable throughout the period studied here, which encompasses two CAP reforms, may be due to the fact that such farms are not highly dependent on CAP subsidies.

During the period studied, technological progress was the highest for mixed farms (27.7%), with an upward trend between 2002 and 2011. Technological change was the highest for the whole French agricultural sector (under the meta-frontier) in 2010, and when taking types of farming separately, it is also clear that the peak of technological change is within 2009-2011, while is has rather decreased during 2006-2008. The decrease occurred after the main CAP reform, which saw the introduction of decoupled payments (SFP), although it could have been expected that such payments may increase technological change and thus productivity change. By contrast, the economic crisis in the following years seems to have forced farmers to adjust their technology.

When technologies are compared to each other using a meta-frontier, results indicate that field crop farms had the most productive technology. This result may be even more confirmed if data on labour were more precise. Labour data are recorded in terms of AWU that is to say of full time equivalents. But one AWU may not have the same meaning in crop farming than in livestock farming, where farmers are known to work long hours to take care of the animals. Hence, if real working hours were accounted for, livestock farms may be even less productive than field crop farms. However, in future research non-agricultural goods should be accounted for when computing and comparing productivity changes across types of farming. Livestock farming and crop farming contribute to various environmental and social goods which are more and more demanded by policy makers and society (Cooper et al., 2009). Findings such as the classification of types of farms may not be the same when these goods are accounted for. Dakpo et al., (2016) for example showed for French sheep meat farms a discrepancy in efficiency evolution depending on whether the focus was on meat or on greenhouse gases.

From a methodological point of view, the Färe-Primont index which, as aforementioned, is multiplicatively complete and satisfies the transitivity property, requires the definition of a representative observation. For our case study, we chose the average observation of the pooled sample containing all the farm types. It is worth mentioning that the decomposition of the Färe-Primont productivity index might be sensitive to this representative observation. Therefore, in further research, for robustness check a sensitivity analysis of this decomposition should be performed using different representative

observations. Subsampling techniques as discussed in Simar and Wilson (2011) can certainly be helpful in dealing with this issue and at the same time deriving statistical properties (confidence intervals).

References

Charnes, A., Cooper, W. W.and Rhodes, E. (1978). Measuring the efficiency of decision making units. *European Journal of Operational Research* 2: 429-444.

Cooper, T., Hart, T.and Baldock, D. (2009). The Provision of Public Goods through Agriculture in the European Union. Report prepared for DG Agriculture and Rural Development, Institute for European Environmental Policy, London.

Dakpo, K. H., Jeanneaux, P.and Latruffe, L. (2016). Greenhouse gas emissions and efficiency in French sheep meat farming: A non-parametric framework of pollution-adjusted technologies. *European Review of Agricultural Economics*.

Färe, R. and Primont, D. (1995). *Multi-Output Production and Duality: Theory and Applications*. Kluwer Academic Publishers.

O'Donnell, C. J. (2008). An aggregate quantity-price framework for measuring and decomposing productivity and profitability change. School of Economics, University of Queensland, Australia.

O'Donnell, C. J. (2011). The sources of productivity change in the manufacturing sectors of the US economy. School of Economics, University of Queensland, Australia.

O'Donnell, C. J. and Fallah-Fini, S. (2011). Comparing Firm Performance Using Transitive Productivity Index Numbers in a Meta-frontier Framework. School of Economics, University of Queensland, Australia.

Minviel, J. J. and Latruffe, L. (2016). Effect of public subsidies on farm technical efficiency: a meta-analysis of empirical results. *Applied Economics*: 1-14.

Simar, L. and Wilson, P. W. (2011). Inference by the m out of n bootstrap in nonparametric frontier models. *Journal of Productivity Analysis* 36: 33-53.