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Using different groups of technological progress as input for sector modeling

Vander Vennet B. and Lauwers L.



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Using different groups of technological progress as input for sector modeling

Vander Vennet B.¹, Lauwers L.¹

Institute for Agricultural and Fisheries Research, Social Sciences Unit, Merelbeke, Belgium

Abstract – This poster aims at describing different groups of technology use within a farm population and at delivering realistic prognoses of their future status as input for sector modeling. This because sector models are in many cases not based on reasonable technological progress estimations or too simplified as normative estimation or seen as mere extrapolation of past evolutions.

The classification and utilization of technology groups is done for livestock activities, but illustrated hereafter for the finishing pigs activities. The research is worked out in three phases:

- Organizational aspects of tuning information demand and supply;
- Identification of technology groups;
- Evolution of technology groups.

Following techniques are used to identify the technology groups:

Stochastic frontier analysis, cluster analysis and others. The results can be used in sector models to measure the impact of induced innovation on different technology groups.

Keywords – technology, sector modeling, induced innovation

I. INTRODUCTION

Sector modeling is an important instrument for policy makers to clarify in which way agro-environmental policies can influence the economic and environmental behavior of farmers. However, too often these model simulations are either not based on reasonable technological progress estimations, or too simplified as normative information or seen as mere extrapolation of past evolutions. Without adequate estimation of technological progress, and in particular the move to more eco-efficiency, policy scenarios will under – or overestimate the impacts of more environmentally friendly incentives.

Currently, the Flemish government wants to

predict until 2030 the impact of more environmentally friendly policy alternatives. For this aim the sector model SELES is used, which was originally developed by LEI of the Netherlands in 1998 [1]. The model is an adaptation of the DRAM model and is based on activities, comparative static and regionalized. This means that the activities of 8 regions are aggregated in 8 regional farms, which means that for each activity only one input/output coefficient exists. The model works without technological progress and it doesn't differentiate between different types of technologies. Nevertheless, the policy makers found it important to incorporate the effect of induced innovation on the environmental behavior of farmers.

This poster aims at describing different groups of technology use within a farm population and at delivering realistic prognoses of their future status as input for sector modeling. The classification and utilization of technology groups is done for livestock activities, but illustrated hereafter for the finishing pig's activities. The research is worked out in three phases:

- Organizational aspects of tuning information demand and supply;
- Identification of technology groups;
- Evolution of technology groups.

II. MATERIALS AND METHODS

A. Tuning information

Before classifying the activities in different technology groups, we need a clear tuning of how technologies are described in the model. Indeed, the research has an important organizational aspect, and implies the collaboration between three actors with different background, each from a different organization: one researcher who classifies activities in different technologies, one who includes the new

data in the model and one policy maker who will use the model for the simulations of the economic and environmental impacts. This knowledge exchange means a big risk in misunderstanding, and intensive communication was needed about the inputs, outputs and calculations of the model. Moreover, technological progress can be approached with different indicators: water use, energy use, input use, manure production or waste production etc. Therefore, a schedule was made about the inputs, outputs and the calculations within the model, completed with possible problems in the calculation, inconsistencies in the model. This schedule made the logics of the model more transparent to outsiders and made it possible for the insiders to discover some mistakes in the model. During the project, this schedule will be continuously adjusted to new discoveries or solutions for possible problems in the calculations.

B. Identification of technology groups

After this important system analysis and communication stage, we identified technology groups, using the stochastic frontier analysis (SFA), based on average from data from 2001 until 2003 of the FADN (Farm Accountancy Data Network). In the case of the pig finishing firms we used kg of concentrates and the number of rotations as inputs and kg of meat as output. We calculated also the cost efficiency, the environmental efficiency (based on the nitrogen content of the inputs and outputs) and the allocative behavior towards cost efficiency and/or environmental efficiency [2]. The problem with this method is that it's using another inputs- outputs description than the sector model (Table 1):

Based on the technical efficiency and the environmental allocative efficiency and the inputs and outputs of the sector model, farms have been clustered with Ward's minimum variance method.

Table 1 Comparison inputs and outputs of the 2 models

Model	Inputs	Outputs
SFA	Kg of concentrates Number of rotations	Kg meat
Sector Model	Kg of concentrates per APA* Number of piglets used as input	Kg meat per APA* Kg of manure per APA*

*APA: Average Present Animal

This made it possible to identify 4 technology groups, with information combining the production theory with the logics of the sector model.

Results were confronted with conventional key figures, such as food conversion, mortality rate, average daily growth etc. and the results were all consistent with the technical efficiency and the environmental allocative efficiency results of the clusters.

C. Evolution of technology groups

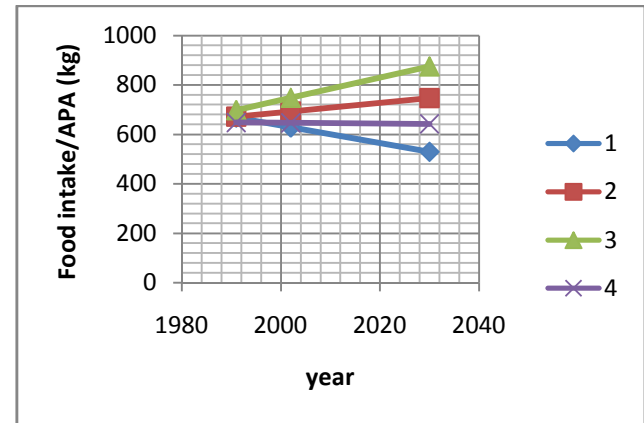


Figure 1. Evolution of the food intake per average present animal (method 1)

After the clustering stage, we want to know the evolution of the technology groups, because those groups will evolve in time. In order to describe this evolution, we used the average of the data of 1990, 1991, 1992 of the FADN. We used two methods: the first is based on the theory that innovators remain to be innovators and that, as a consequence, the farmers of one technology group don't move to another technology group after a certain period of time. The results of the farms of one cluster in 2001-2003 were compared with the results of 1990-1992 of the same farms and projected to the year 2030. This hypothesis results in an overall diverge of groups (figure 1), which seems not to be correct, because in reality there is rather trend toward converging of the technology groups (figure 2).

This method is therefore not the correct way to predict the evolution of technology groups. The second method assumes that that structural change is possible and that farms of one technology group can

move towards another group. To discover the technology groups in the period of 1990-1992, a discriminant analysis is made of the clusters of the period of 2001-2003 and used for classifying also the 1990-1992 farms in similar technology groups.

After comparing the movement of the clusters, we see that farms indeed move from one cluster to another, and that the efficient clusters are more stable than the inefficient clusters. After the projection of the parameters, we see that the technology groups converge to each other, but still have another behavior in cost structure and food conversion (figure 3).

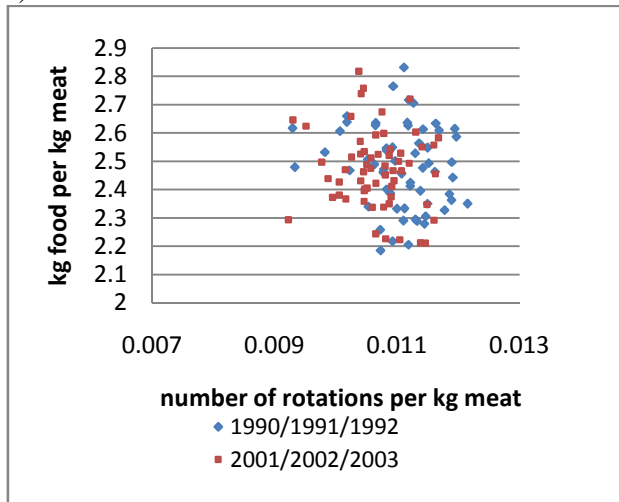


Figure 2. Distribution of input combination of the two periods.

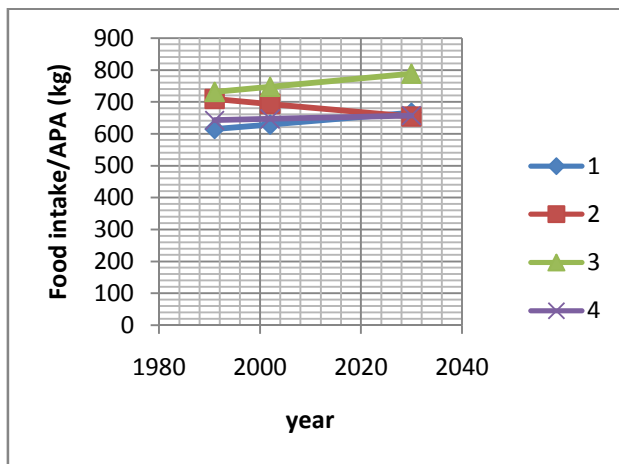


Figure 3. Evolution of the food intake per average present animal (method 2)

III. RESULTS AND DISCUSSION

A. Tuning information

The use of a schedule with all possible information improved the communication seriously. However it needed some discipline to continue using the schedule as a communication instrument.

B. Identification of the technology groups

The use of a multivariate technique like cluster analysis makes it possible to divide a population on all parameters that are used in the sector model, combined with the production theory. The result of this method is that the production theory is integrated in the sector model and that the different technology groups maximally differ from each other in the multidimensional space of different parameters. A side effect from this method is that, if each parameter apart is compared within the other groups, the parameters of the different groups do not differ very much from each other. But, on the other hand, if the sector model analyses different policies, which can be both economically or environmentally, technology groups will react on a different way on all possible policies.

C. Evolution of the different technology groups

By observing the properties of different technology groups in different periods, technological progress can be differentiated for each technology group, which makes it possible to measure *ex ante* the effects of induced innovation.

The first method shows that the theory of innovation diffusion is not the only theory to explain technological progress, but that structural change is also an explaining factor. The reason however why this structural change is happening is not explained. An uncertainty of the second method is in which way the statistical method of clustering followed by a discriminant analysis has unknown effects in the division in technology groups and their technological progress.

Another factor not yet explained is in which way induced innovation has effects on, on the one hand

the technology diffusion process and on the other hand structural change, which makes enterprises moving from one technology group to another.

IV. CONCLUSION

This study gives opportunities for using past observations about structural change for model calibration and impact of induced innovation towards more eco-efficient agricultural production.

The different properties of the different technology groups will result that they will interact in a different way on induced innovation with, for each technology group a different path of evolution.

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Corresponding author:

- Author: Bert Vander Vennet
- Institute: Institute for Agricultural and Fisheries research, Social Sciences Unit
- Street: Burg. Van Gansberghelaan 115 box 2
- City: Merelbeke
- Country: Belgium
- Email: bert.vandervennet@ilvo.vlaanderen.be