Technical efficiency and productivity change of dairy farms: A comparison of France and Hungary

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Paper prepared for presentation at the I Mediterranean Conference of Agro-Food Social Scientists. 103rd EAAE Seminar '*Adding Value to the Agro-Food Supply Chain in the Future Euromediterranean Space*'. Barcelona, Spain, April 23rd - 25th, 2007

Contributed paper for the 103rd EAAE seminar "Adding Value to the agro-Food Supply Chain in the future Euro Mediterranean Space", Barcelona, 23-25 April 2007

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Abstract

The paper investigates the difference in technical efficiency, productivity and technology between French and Hungarian dairy farms, in 2001 and 2002, using Data Envelopment Analysis with separate and a common frontier. Results indicate that Hungarian farmers are more clustered to their own frontier than French farms are, but French farms are, on the other hand, more scale efficient. Both samples have increased their productivity between both years, with a higher technological change for Hungary. Comparing the technology of both countries reveals that Hungarian farms have a superior technology. Under a common hypothetical technology, Hungarian farms would be the leaders but French farms would nevertheless succeed in increasing their productivity as much as they do under their own frontier.

Keywords: technical efficiency, productivity factor, dairy farms, France, Hungary

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1. Introduction

The paper investigates the difference in technical efficiency, productivity and technology between French and Hungarian dairy farms in 2001 and 2002. Technical efficiency, that is to say the ability of a farm to use the best existing technology in terms of quantities, is calculated firstly under separate frontiers, in order to assess the room for improvement within each country. Then, the measure is calculated with a common frontier, that is to say with a merged sample of both countries, in order to understand which country is lagging behind in terms of technology and thus might hinder productivity growth in the European Union (EU). Productivity change for both countries is also investigated and compared, as well as its components technical efficiency change and technological change.

Comparing two countries in terms of efficiency and technology has not been widely studied. In the EU, one can mention the study by Brümmer et al. (2002) about dairy farms in Germany, the Netherlands and Poland over the period 1991-1994. The authors use a parametric approach, namely the stochastic frontier analysis, which enables them to perform a test of poolability of the three samples. On the basis of the test's results, the authors reject the hypothesis of the possible merging of the three countries, and therefore provide results for country-specific efficiency and productivity change. Poland is found to have the lowest average technical efficiency and experienced a decrease in productivity change (with regards to its own frontier), while there was a growth in both EU-15 countries.

By contrast, in this paper the non-parametric approach Data Envelopment Analysis (DEA) is employed, giving the possibility to merge countries and investigate the technology gap between

them, without having to test for the poolability hypothesis. The method is that proposed by Charnes et al. (1981) in the case of two types of education programmes, and has for example been used by Oude Lansink et al. (2002) to compare organic and conventional farms' technology in Finland.

France and Hungary, the countries compared in this paper, have been chosen because they differ largely in terms of natural and economic conditions. Dairy farming in France is mostly located in the Western lowlands (Brittany, Normandy) (45% of the country's dairy area) and in mountainous areas (Alps, Jura and Central France) (28% of the country's dairy area). During the period studied, French farmers benefited from intervention prices for specific dairy products in the frame of the Common Agricultural Policy (CAP); for example, intervention price for butter was about 328 euros per 100 grams in 2001. However, French dairy farms are subject to production quotas, and they can also receive financial assistance for closing down their dairy activity, both measures being active since 1984 in an objective of reducing the milk production. In Hungary dairy farms are predominantly located in the Northern Great Plain and Southern Great Plain (43% of the country's dairy area) as well as in the Transdanubian area (Central Transdanubia, Western Transdanubia and Southern Transdanubia) (42% of the country's dairy area). During the studied period market economy in Hungary became effective due to political and economic reforms started after the fall of the communist regime at the same time agricultural policy was focused on EU accession. The privatised milk processing industry operated by famous brands (Parmalat, Friesland, Danone, Bongrain, etc.) influenced the milk production in terms of quantity and quality. National support to milk production was mainly in the form of price support as an effort of agricultural policy to prevent milk production falling which decreased from 2,763 to 2,081 million litres in 1990 and 2000 respectively. Fertő et al. (2006) showed with an accelerator model that Hungarian farmers' investment decisions were constrained between 2000 and 2004 due to

lack of financing. During the transition, Hungarian dairy farmers might thus not have been able to replace a potentially obsolete technology. Public support can however help relaxing credit constraints and thus undertaking investment. This might have been the case in Hungary, as the Producer Support Estimate (PSE) calculated by the OECD for milk production in Hungary was 42% and 57% in 2001 and 2002 respectively, while the figures were 31% and 45% in the EU. Thus, whether French farms have a superior technology than Hungarian farms, due to the potential financing obstacles from Hungarian farmer during the period studied, might not be certain.

The paper is structured as follows. The next section explains the methodology used, while the third section presents the data. Results and conclusions are given in the fourth and fifth sections, respectively.

2. Methodology

2.1. Yearly technical efficiency

The non-parametric method DEA is preferred in this paper over the stochastic frontier method. The latter necessitates assumptions about the production function and the error term distribution, and therefore might comprise potential misspecifications. By contrast, DEA uses linear programming to construct the efficient frontier with the best performing observations of the sample used, so that the frontier envelops all observations (see Charnes et al., 1978). The distance from a farm to the frontier provides a measure of its efficiency. DEA also enables to assess under which returns to scale each farm operates and to calculate their scale inefficiency. Calculating efficiency under the assumption of constant returns to scale (CRS) gives the total technical efficiency score, while assuming variable returns to scale (VRS) allows calculating one

component of this total efficiency score, namely the pure technical efficiency. The latter captures the management practices, while the residual between total technical efficiency and pure technical efficiency shows whether the farm operates under optimal farm size. This residual is called scale efficiency. Efficiency scores are given between 0 and 1, 1 indicating a fully efficient farm (i.e. on the frontier) and a larger score showing a higher efficiency.

An output-orientated model is used, with one output – the value of total output in euros –, and four inputs – the utilised area in hectares, the labour used in Annual Working Units (AWU), the value of total assets in euros, and the value of intermediate consumption in euros. Values were deflated by relevant price indices.

Yearly efficiencies are calculated, that is to say a frontier is constructed for each year. In order to compare the performance between France and Hungary, firstly separate frontiers for each country are used. This can show how farms in each country perform with respect to their own country's technology. Then both countries are merged in a common sample and a common frontier is constructed. This allows to investigate which country has the most productive technology, by calculating a productivity factor for each farm, as the ratio between the efficiency calculated under the common frontier and the efficiency calculated under the respective country's frontier. Average productivity factors for French farms and Hungarian farms are then compared, the higher average indicating the superior technology.

2.2. Efficiency, technological and productivity changes

Productivity change is also calculated with DEA, using the concept of Malmquist indices (see Färe et al., 1992). These indices rely on comparing the distance to the frontier in 2001 with the distance to the frontier in period 2001. Malmquist indices of Total Factor Productivity (TFP) change can be decomposed into technical efficiency change and technological change. The

former shows whether farms move closer or further from the frontier over time, while the latter captures the shift in technology. Moreover, technical efficiency change can itself be decomposed into pure technical efficiency change and scale efficiency change. An index of 1 indicates no change, while an index greater (less) than 1 reveals an increase (decrease) in the variable considered (efficiency, technology, productivity).

Productivity, efficiency and technological changes are firstly investigated for each country with respect to their own frontier. Secondly, the indices are calculated for the merged sample (France and Hungary together), that is to say as if the technology was common between both countries.

3. Data

FADN data are used for both countries. Farms with the type of farming dairy (TF41) were extracted in order to have a balanced panel between 2001 and 2002 in both countries. The French sample consists of 268 farms per year, while the figure is 67 for Hungary.

Table 1 presents the average output and inputs for both countries over the period studied. Hungarian farms are much larger than French farms; for example, they operate on average 310 ha of land against 56 for French farms. In both countries, total output has increased between 2001 and 2002. Input use in France has stagnated, for all factors, while in Hungary capital and intermediate consumption have increased, to the detriment of land and labour.

Table 1: Description of the samples: Average values (deflated values for 2002)

	France			Hungary		
	2001	2002	Whole period	2001	2002	Whole period
Total output (ths euros)	85.1	90.3	87.7	561.4	635.0	598.2
Utilised land (ha)	55.3	56.0	55.7	318.2	301.0	309.6
Labour (AWU)	1.51	1.52	1.52	17.61	15.83	16.72
Capital (ths euros)	205.7	204.1	204.9	612.0	669.1	640.6
Intermediate consumption (ths euros)	48.4	48.9	48.6	271.9	279.5	275.7
Number of observations	268			67		

4. Results

4.1. Performance in each country (separate frontiers)

Table 2 presents the descriptive statistics for technical efficiency calculated with regard to the respective frontier. In 2001, the average total technical efficiency (under CRS) is similar for both countries (around 0.72), suggesting that in both samples, farms were relatively homogenous. However, French farms were less homogenous in terms of management practices (lower average technical efficiency under VRS) but more homogenous in terms of size (higher average scale efficiency) than Hungarian farms. The latter can be explained by the fact that Hungarian farms are more diverse in terms of size than French farms: the minimum and maximum utilised areas in the Hungarian sample in 2001 are 4 ha and 2,540 ha, while the respective figures for the French sample are 12 ha and 209 ha. The difference in size between both samples is also reflected in the shares of farms according to their returns to scale. The majority of farms in the French sample

were operating under IRS in 2001, indicating that they were too small, while in Hungary the majority of farms were equally split between too small farms (under IRS) and too large farms (under DRS).

Table 2: Yearly technical efficiency (TE); separate frontiers

	France		Hungary	
	2001	2002	2001	2002
Number of observations	268	268	67	67
Average TE under CRS	0.713	0.709	0.722	0.766
Average TE under VRS	0.777	0.780	0.809	0.838
Average scale efficiency	0.922	0.911	0.901	0.921
Share of farms with score of 1:				
for TE under CRS (%)	4	4	10	15
for TE under VRS (%)	14	13	34	37
for scale efficiency (%)	6	6	10	15
Share of farms under:				
CRS (%)	6	8	12	18
IRS (%)	71	68	42	42
DRS (%)	23	24	46	40

Comparing the technical efficiency statistics between both years reveals that, while the homogeneity of French farms remained approximately the same, farms in the Hungarian sample became more clustered to the efficient frontier, since the average technical efficiencies (total,

pure and scale) are higher in 2002 and 2001. This suggests that there has been an improvement in the farming practices in Hungarian farms between 2001 and 2002.

Table 3: Change over time of technical efficiency (TE), technology and Total Factor Productivity (TFP); separate frontiers

	France	Hungary
	2001-2002	2001-2002
Number of observations	268	67
Average total TE change	0.993	1.064
Average pure TE change	1.003	1.040
Average scale efficiency change	0.990	1.024
Average technological change	1.078	1.027
Average TFP change	1.071	1.093
Share of farms with total TE change:		
=1 (stagnation) (%)	2	6
>1 (increase) (%)	47	30
<1 (decrease) (%)	51	64
Share of farms with technological change:		
=1 (stagnation) (%)	1	3
>1 (increase) (%)	81	78
<1 (decrease) (%)	18	19
Share of farms with TFP change:		
=1 (stagnation) (%)	0	0
>1 (increase) (%)	68	67
<1 (decrease) (%)	32	33

Calculating the productivity change with Malmquist indices allow to investigate this issue more in depth. Table 3 displays the results regarding these calculations. The main result is that both samples show a productivity progress on average (by 7% for French farms, 9% for Hungarian farms), and that the majority of the farms have experienced an increase (indices greater than 1). French farms have on average neither improved nor worsened their efficiency (total technical, pure technical and scale), as the average efficiency changes of the sample are approximately 1. They have however experienced a technology progress, of 8%, resulting in a TFP increase of 7%. Hungarian farms also showed a productivity increase, and even greater than French farms: of 9%. This increase is the result of both an efficiency improvement (by 6% in total) and a technological progress (of 3%). The high technological progress of French farms is not surprising, looking at the summary statistics of Table 1: output has increased between both years, without any increase in the input use. It is however interesting to see that, despite a strong technological progress, all farmers have managed to follow and adapt their practices to the new technology. It is indeed not rare to see opposite patterns between technological change and efficiency change, as a technological progress often results in a delay for some farmers to adopt the new technique or use it efficiently (e.g. Brümmer et al., 2002; Balcombe et al., 2005). The opposite pattern is not witnessed either for the Hungarian sample, but the technological progress has been lower.

4.2. Comparison of the countries' technologies (common frontier)

As the interest is in the comparison of the performance of each country, the results using a common frontier are not presented for the pooled sample, but for each country only. Table 4 shows the descriptive statistics of the technical efficiency in 2001 and 2002, of France and

Hungary, when a common frontier is used. The results for the pooled sample are given in Appendix.

Table 4: Yearly technical efficiency (TE); common frontier; results for both countries

	France		Hungary	
	2001	2002	2001	2002
Number of observations	268	268	67	67
Average TE under CRS	0.568	0.601	0.722	0.760
Average TE under VRS	0.616	0.633	0.808	0.834
Average scale efficiency	0.925	0.951	0.902	0.919
Share of farms with score of 1:				
for TE under CRS (%)	0	4	10	13
for TE under VRS (%)	2	13	34	36
for scale efficiency (%)	1	6	10	13
Share of farms under:				
CRS (%)	2	10	12	17
IRS (%)	21	77	42	40
DRS (%)	77	13	46	43
Average productivity factors				
under CRS	0.796	0.851	0.99994	0.993
under VRS	0.796	0.815	0.9990	0.995

Table 4 reveals that Hungarian farms display much higher average total and pure technical efficiencies than French farms, in both years; for example the average total technical efficiency in 2002 was 0.76 for Hungarian farms, and 0.60 for French farms. This suggests that more Hungarian farms are close to the efficient frontier than French farms. French farms however seem

to perform better in terms of scale efficiency. Thus, it suggests that, if it is assumed that French and Hungarian farms have access to the same technology, than Hungarian farmers would have better management practices, while French farms would be more able to adjust their operation size. Comparing the results in 2002 with those in 2001 reveal that for both countries the efficiency has increased on average, indicating a reduced heterogeneity in both samples.

Table 4 also gives the productivity factors, calculated under CRS and VRS. The productivity factors for Hungarian farms are very close to 1 in both years, while it is less than 0.85 for French farms. This suggests that Hungarian farms have a more performing technology than French farms. This is confirmed by the shares of farms on the efficient frontier, which are larger for Hungary than for France. Hungarian farms thus lead the sample in terms of technology. The discrepancy between both countries in terms of productivity factors however decreases between 2001 and 2002, indicating that French farms' technology is becoming more similar to the one used by Hungarian farms.

A similar picture is given by the results regarding the Malmquist indices for each country under a common frontier, presented in Table 5. They indicate that efficiency, technological and productivity changes for Hungarian farms are on average the same as under a separate frontier, confirming that those farms are the leaders of the pooled sample. French farms, by contrast, have a stagnation in their technology, while they had a high technological progress with respect to their own frontier. This confirms that French farms would not contribute to the hypothetical common technological progress. This low result is however compensated by a large increase in technical efficiency (6%), which enables the French farms to have a similar TFP progress as when they are considered with respect to their own frontier only (7%).

Table 5: Change over time of technical efficiency (TE), technology and Total Factor Productivity (TFP); common frontier; results for both countries

	France	Hungary
	2001-2002	2001-2002
Number of observations	268	67
Average total TE change	1.064	1.056
Average pure TE change	1.032	1.035
Average scale efficiency change	1.031	1.021
Average technological change	1.005	1.039
Average TFP change	1.069	1.098
Share of farms with total TE change:		
=1 (stagnation) (%)	1	6
>1 (increase) (%)	68	63
<1 (decrease) (%)	31	31
Share of farms with technological change:		
=1 (stagnation) (%)	1	2
>1 (increase) (%)	61	85
<1 (decrease) (%)	38	13
Share of farms with TFP change:		
=1 (stagnation) (%)	0	0
>1 (increase) (%)	70	70
<1 (decrease) (%)	30	30

5. Conclusions

The paper has investigated the performance of French and Hungarian dairy farms, with respect to their own technology frontier, and has compared their technology. The analysis was performed in 2001 and 2002, when Hungary was at the end of its transition period and preparing for EU

accession, while French farms were not subject to major policy changes (the Agenda 2000 did not affect deeply the Common Market Organisation for milk).

Regarding the performance related to their own frontier, Hungarian farms were found to be more homogenous in terms of their farming practices than French farms. This suggests that, despite the new technologies introduced in Hungary during the transition period, farmers in this country were able to quickly adapt their practices to the new technique. However, Hungarian dairy farming shows larger scale heterogeneity than French farming. Both samples show close average productivity increase, but the sources of this progress is different. The evolution between 2001 and 2002 has been nil in terms of efficiency for French farms, but their technological progress has been substantial, while Hungarian farms show both small efficiency and technological progress. The separate analysis therefore gives an optimist picture for both countries.

Looking at the results with a common frontier showed much more discrepancy between both countries. The most striking finding is that Hungarian farms are leading the technology. It could have been expected, by contrast, that Hungarian farms would lag far behind French farms, as they might not have the access to modern technology during the transition period, either because this technology was not available or because most farms were financially constrained. This paper seems to reveal however that Hungarian farms have had access to technological improvement, and the higher PSE for these farms, compared to EU farms, suggests that public subsidies have helped in the transformation. It is indeed interesting to note that in both samples studied here, farm performance and public support develop together: not only Hungarian farms perform better, and are more supported, than French farms, but also for both farms performance improvement between 2001 and 2002 is also accompanied by an increase in the PSE.

This analysis has been performed a couple of years before the EU enlargement. The accession of Hungary to the EU enables its farmers to receive European subsidies, in the form of Single Area

Payments. Although this support is lower than what the French farmers receive at the same time due to the phasing-in, it is higher than pre-accession support. It might therefore increase even more Hungarian farms' technological superiority. However, French dairy farms have also faced a policy change recently, with the shift to the Single Farm Payment. Thus, the technology gap between France and Hungary might not increase dramatically. French farms have shown already that, under the hypothetical common frontier, they would have been able to improve their productivity as much as they would have done with respect to their own technology.

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Appendix

Table 6: Yearly technical efficiency (TE); common frontier; result for the pooled sample (France + Hungary)

	Pooled sample	
	2001	2002
Number of observations	335	335
Average TE under CRS	0.598	0.633
Average TE under VRS	0.654	0.673
Average scale efficiency	0.920	0.945

Table 7: Change over time of technical efficiency (TE), technology and Total Factor Productivity (TFP); common frontier; results for the pooled sample (France + Hungary)

	Pooled
	2001-2002
Number of observations	335
Average total TE change	1.062
Average pure TE change	1.033
Average scale efficiency change	1.029
Average technological change	1.012
Average TFP change	1.075