Technical efficiency and technology in Eastern and Western agriculture: A comparison of crop and dairy farms in Hungary and France

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ABSTRACT

The paper investigates the difference in technical efficiency and technology between French and Hungarian farms in dairy and cereal, oilseed and protein seed (COP) sectors during 2001-2004. The analyses is performed with Data Envelopment Analysis (DEA) under separate and common frontiers. Results indicate that Hungarian dairy farmers are more clustered to their own frontier than French farms are, but that the difference is less clear in COP farming. Hungarian dairy and COP farms are less scale efficient than French farms on average. Under a common hypothetical technology, Hungarian farms would be the leaders. Reasons might be the presence of large corporate farms and a higher public support in Hungary.

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

1 INTRODUCTION

Technical efficiency of farms in Central and Eastern European Countries (CEECs) during the transition has received large attention from researchers (for a review, see GORTON and DAVIDOVA, 2004). Results generally agreed that there was a substantial potential improvement for these farms, and related the low efficiency to market and institutional failures that prevented farmers to close the gap to the efficient frontier. Findings of a low average efficiency score can only indicate that the sample considered was relatively heterogeneous in terms of scale and management practises. Such analyses, therefore, shed light on which farms were laying backwards within the country, but did not assess the country's technology. This issue is however becoming increasingly important with the European Union (EU) enlargement, as farms from CEECs will have to compete with their EU-15 counterparts on the single market. The expectation on the relative performance of CEECs compared to the EU-15 is ambiguous. On the one hand, the technology might be obsolete as farmers' investment decisions might have been constrained by the lack of financing (e.g. LATRUFFE, 2005; FERTÖ et al., 2006); on the other hand, most of the CEECs have a large share of corporate farms, whose large production scale might give an advantage to these countries.

This paper proposes to start the debate for Hungarian farms specialised in two of the country's major outputs: milk (Type of Farming TF41) and cereals, oilseeds and protein seeds (COP) (TF13). In order to assess Hungarian dairy and COP farms' technology, a comparison with another EU-15 country is necessary. France is a good benchmark, as it is one of the major producers of COP and milk in the EU-15 with 30% and 20% respectively. Moreover France is a an important import supplier for Hungary in for these commodities, particularly for COP products (third import country). Furthermore, Hungarian and French COP and dairy products are competing on the foreign markets inside and outside the EU-27.

The objective of the paper is to investigate how farms in Hungary and France differ in terms of technical efficiency, and which country has a superior technology. 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 EU.

2 METHODOLOGY AND DATA

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. This method enables to investigate which country has the most productive technology, by calculating a productivity factor for each farm, the higher sample's average indicating the superior technology.

Contrary to the stochastic frontier method, DEA does not necessitate assumptions about the production function and the error term distribution, and therefore potential misspecifications are avoided. 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.

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.

An output-orientated model is used. For dairy farms (TF41), the model includes two outputs – the quantity of milk produced in litres and the value of other output in euros –, and five inputs – the utilised area in hectares, the labour used in Annual Working Units (AWU), the value of total assets in euros, the value of intermediate consumption in euros, and the number of livestock units (calculated with the EU definition). For COP farms (TF13), the model includes

one output – the value of total output in euros –, and four inputs – the same as for dairy farms except the livestock units. Values were deflated by relevant price indices.

Balanced panels of FADN data over the period 2001-2004 are used for both countries. Table 1 presents the average output and inputs for both countries over the period studied. Hungarian farms are much larger than French farms, in particular in the dairy sector. For example, the Hungarian COP sample operates on average 247 ha of land against 145 ha for French COP farms, and the respective figures for dairy farms are 356 ha and 74 ha. The size difference is kept for the other production factors and the outputs in the dairy sector. However, in the COP sector, Hungarian farms produce only slightly more total output and, while they are much more labour intensive (they use twice as much AWU as French farms), French farms are more capital intensive. The evolution over the period is not shown in the table. The main features of this evolution is that the French dairy and COP samples have experienced very slight changes in their output produced and their input use, while the Hungarian dairy farms' outputs and inputs have rather fluctuated, and the Hungarian COP farms' output has increased, the capital use has almost double, but the labour use has decreased.

Table 1: Description of the samples: Average values for the whole period 2001-2004

	Dairy farms (TF41)		COP farms (TF13)	
	France	Hungary	France	Hungary
Total output (ths euros)	-	-	112.9	156.9
Milk produced (ths litres)	255.4	1,434.0	-	-
Other output (ths euros)	34.5	264.1	-	-
Utilised land (ha)	74.2	355.9	144.9	246.8
Labour (AWU)	1.78	19.1	1.57	3.91
Capital (ths euros)	219.3	498.8	190.6	137.5
Intermediate consumption (ths euros)	67.7	334.4	77.1	74.9
Number of livestock units	85.5	380.4	-	-
Number of observations per year	684	35	905	278

3 RESULTS

3.1. Performance in each country (separate frontiers)

Table 2 presents the descriptive statistics for technical efficiency calculated with regard to the respective frontier. Regarding dairy farms, for the whole period 2001-2004, the average total technical efficiency (under CRS) is lower for France (0.764) than for Hungary (0.868). This difference mainly stems from a difference in pure technical efficiency (under VRS) (0.801 vs. 0.914) rather than a difference in scale efficiency (0.954 vs. 0.948). This suggests that the French dairy sample was less homogenous in terms of management practices but as homogenous in terms of size as the Hungarian dairy sample. Hungarian dairy farms that were not scale efficient were operating for the majority under decreasing returns to scale (DRS), indicating that they were too large, while the non scale efficient farms in the French dairy sample were equally split between too small farms (under increasing returns to scale, IRS) and too large farms (under DRS). As for COP farms, over the whole period the average total technical efficiency (under CRS) is similar for both countries, with a short superiority for French farms (0.474 for France and 0.421 for Hungary). The low performance in terms of

total technical efficiency for both countries mainly come from low pure technical efficiency (under VRS) (0.516 and 0.475), indicating that COP farms in both countries were very heterogeneous in terms of management practices. The scale efficiency is on average high in both countries (0.929 and 0.909), suggesting that COP farms operated close to their optimal size. In both countries, those farms that were not fully scale efficient were equally split between too small farms (under IRS) and too large farms (under DRS).

Table 2: Yearly technical (TE) and scale efficiency as average for the whole period 2001-2004; separate frontiers

	Dairy farms (TF41)		COP farms (TF13)	
	France	Hungary	France	Hungary
Average TE under CRS	0.764	0.868	0.474	0.421
Average TE under VRS	0.801	0.914	0.516	0.475
Average scale efficiency	0.954	0.948	0.929	0.909
Share of farms with score of 1:				
for TE under CRS (%)	6	46	1	4
for TE under VRS (%)	12	64	3	8
for scale efficiency (%)	9	46	8	6
Share of farms under:				
CRS (%)	9	46	10	9
IRS (%)	45	17	47	49
DRS (%)	46	37	43	42
Number of observations per year	684	35	905	278

As Figure 1 shows for dairy farms, comparing the technical efficiency statistics between each year reveals that, while the homogeneity of both samples remained approximately the same over the first three years, farms in both samples sample became less clustered to the efficient frontier, since the average technical efficiencies (total, pure and scale) decreased in 2004. This suggests that there has been a worsening in the farming practices in dairy in both countries between 2001 and 2004, especially in Hungary where the decrease in efficiency is sharper. Figure 2 compares the technical efficiency statistics between each year for COP farms, revealing that, while the homogeneity of the French sample remained approximately the same over the period, farms in the Hungarian sample became less clustered to the efficient frontier in 2003, since the average technical efficiencies (total, pure and scale) decreased. This suggests that there has been a worsening in the farming practices in Hungary COP farming between 2001 and 2003. However, COP Hungarian farms increased their efficiency again in 2004, catching up with the French sample.

Figure 1: Evolution of yearly technical (TE) and scale (SE) efficiency in 2001-2004 for dairy farms in France (FR) and Hungary (HU); separate frontiers

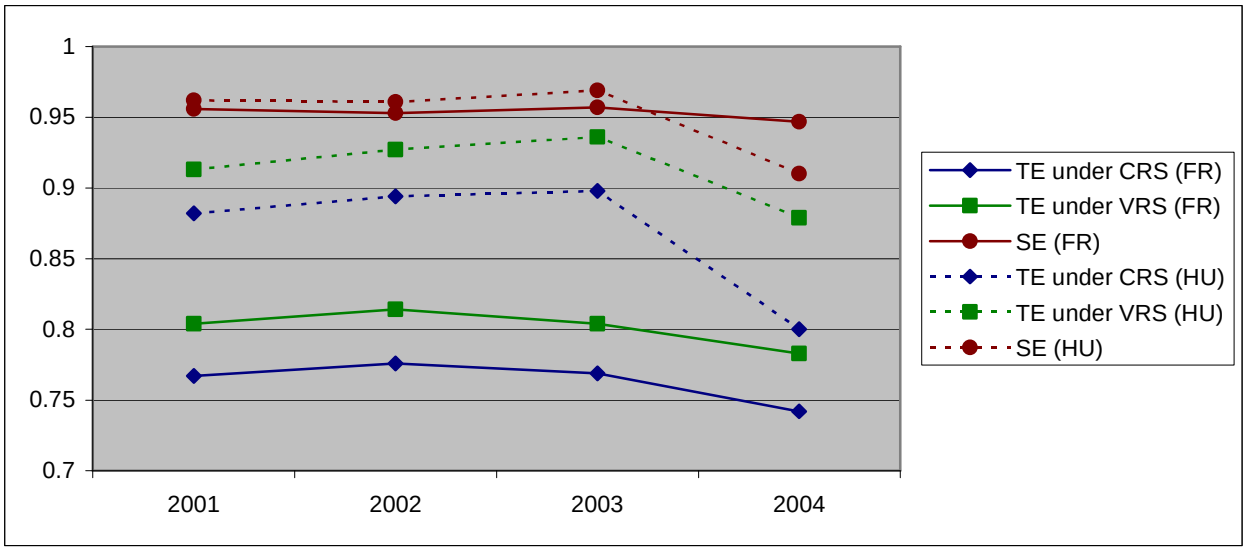
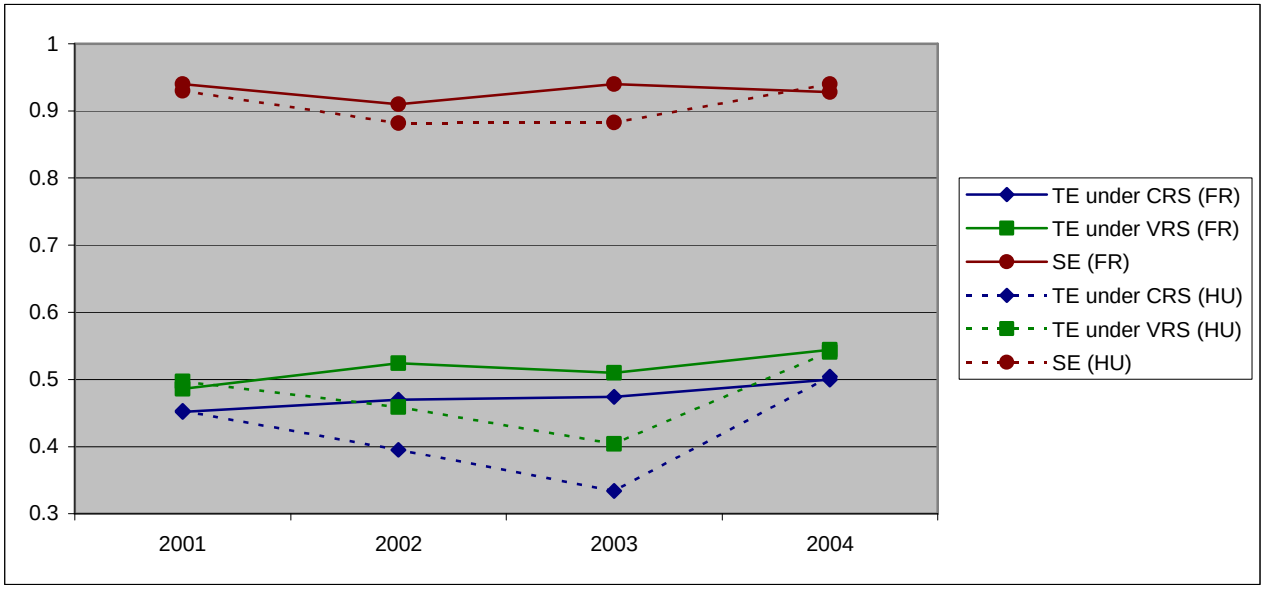


Figure 2: Evolution of yearly technical (TE) and scale (SE) efficiency in 2001-2004 for COP farms in France (FR) and Hungary (HU); separate frontiers



3.2. 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 3 shows the descriptive statistics of the technical efficiency of France and Hungary, when a common frontier is used. The results for the pooled sample are given in Appendix.

Table 3: Yearly technical efficiency (TE) as average for the whole period 2001-2004; common frontier; results for both countries

	Dairy farms (TF41)		COP farms (TF13)	
	France	Hungary	France	Hungary
Average TE under CRS	0.707	0.835	0.400	0.412
Average TE under VRS	0.743	0.892	0.424	0.465
Average scale efficiency	0.950	0.934	0.949	0.911
Share of farms with score of 1:				
for TE under CRS (%)	4	37	1	4
for TE under VRS (%)	5	61	1	8
for scale efficiency (%)	7	38	5	5
Share of farms under:				
CRS (%)	8	38	8	8
IRS (%)	35	19	34	47
DRS (%)	57	43	58	45
Average productivity factors				
under CRS	0.925	0.958	0.845	0.982
under VRS	0.927	0.974	0.830	0.979
Number of observations per year	684	35	905	278

Table 3 reveals that Hungarian dairy and COP farms display higher average total and pure technical efficiencies than French farms over the period studied; for example, the average total technical efficiency was 0.835 for Hungarian dairy farms, and 0.707 for French dairy farms. This suggests that more Hungarian farms are closer to the efficient common frontier than French farms. French dairy and COP farms however seem to perform slightly better in terms of scale efficiency (0.950 vs. 0.934 for dairy farms). Thus, it suggests that, if it is assumed that French and Hungarian farms have access to the same technology, Hungarian farmers would have better management practices, while French farms would be more able to adjust their operational size. Not shown in the table is the evolution of technical efficiency over the period, but the main point to note about this evolution is that it is similar to the evolution of technical efficiency calculated with separate frontiers both for dairy and COP samples, except that French COP farms also experienced a decrease in efficiency decrease in 2003 under the common frontier.

Table 3 also gives the productivity factors, calculated under CRS and VRS. The average productivity factors over the whole period are greater for Hungarian dairy and COP farms (for example 0.982 and 0.979 under CRS and VRS respectively) than for French farms (0.845 and 0.83). This suggests that Hungarian farms had on average a more performing technology than French farms, in dairy and in COP sectors. 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. However, Figure 3, picturing the evolution of the productivity factors over the period for dairy farms, shows that the discrepancy between both countries is not so definite. Under VRS (management practices only), while the average productivity factor of the Hungarian sample is greater than the French dairy sample's one in each year, the difference between both countries is reduced in 2004. Regarding the productivity factors under CRS (management practices and scale), in two years (2002 and 2004) the French average is greater than the Hungarian average. Thus, French and Hungarian dairy farms' technology is actually more similar than Table 3 was showing, with French farmers catching up in the last year. But regarding COP farming, Figure 4, shows that the discrepancy between both countries is clear-cut for the whole period and thus confirms Table 3's findings: the average productivity factor of the Hungarian COP sample is greater than the French COP sample's one in each year.

The French samples are considerably larger than the Hungarian sample. To control for a potential sample size bias in the results, all analyses have been redone with a French dairy sample of 35 farms only, drawn randomly from the original 684 farms, and a French COP sample of 278 farms only, drawn randomly from the original 905 farms. Output and input characteristics of the reduced samples are similar to those of the original large samples. As for the results, they are in general confirmed. The only major difference is that the average technical efficiencies for French farms under the separate frontier are greater for the reduced samples than for the original large samples, which is expected (smaller samples show larger average efficiency).

Figure 3: Evolution of productivity factors in 2001-2004 for dairy farms in France (FR) and Hungary (HU)

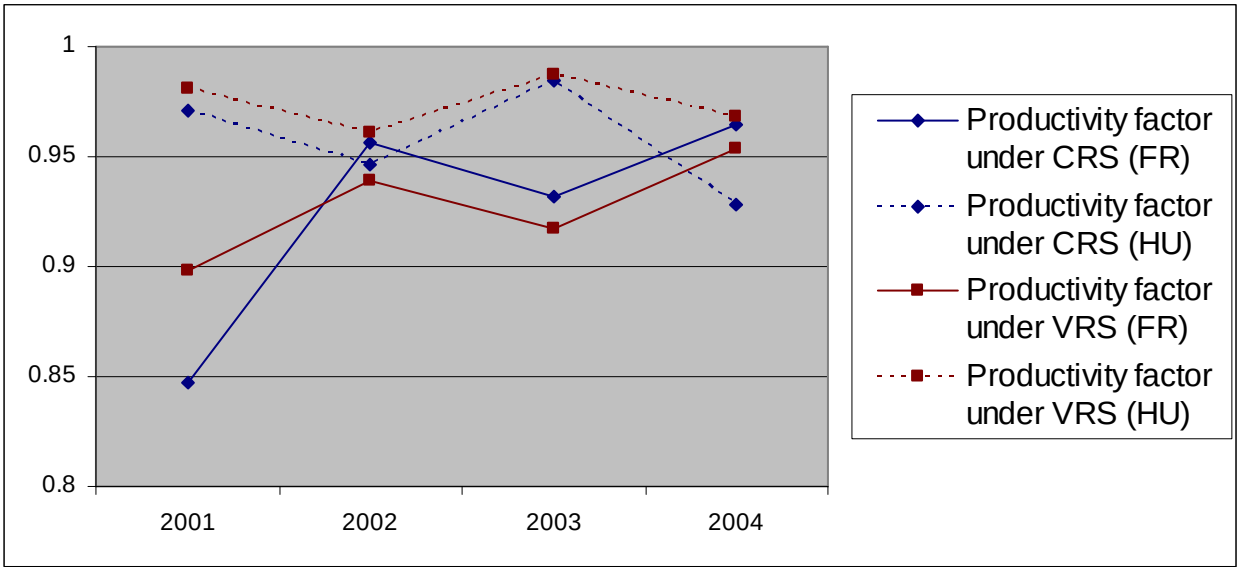
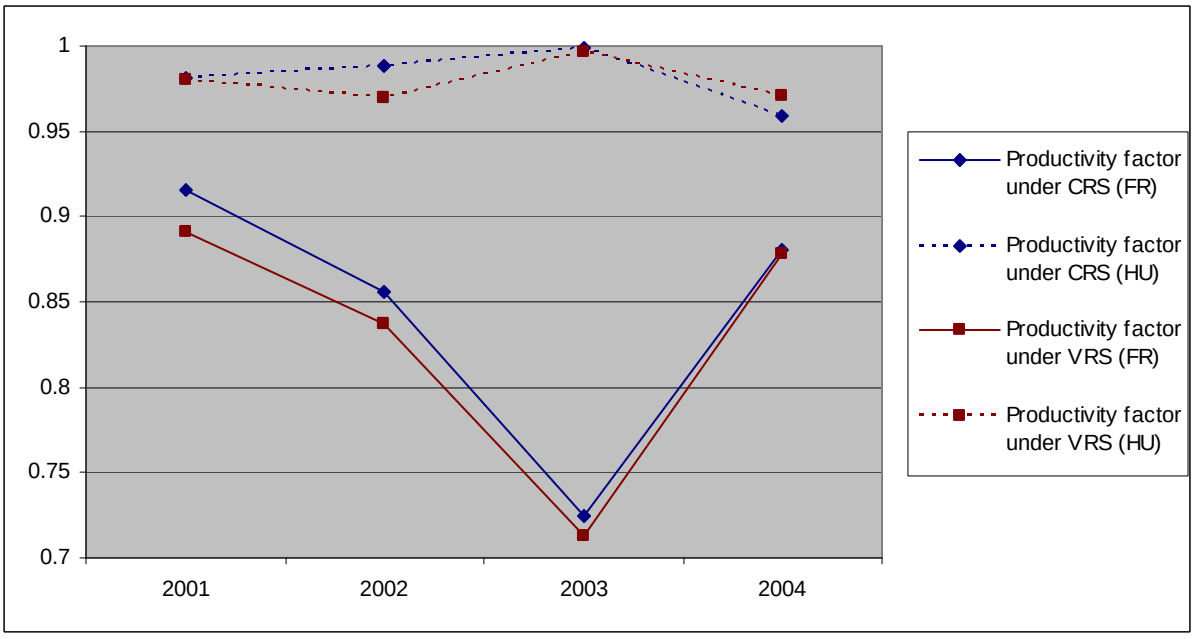


Figure 4: Evolution of productivity factors in 2001-2004 for COP farms in France (FR) and Hungary (HU)



4 CONCLUSIONS

The paper has investigated the performance of French and Hungarian farms, with respect to their own technology frontier, and has compared their technology, in fairy and COP sectors. The analysis was performed during the period 2001-2004, 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 and did not imply reduced support despite the move towards area payments).

Regarding the performance related to their own frontier, in dairy farming Hungarian farms show similar scale heterogeneity than French farms, but Hungarian farms were found to be more homogenous in terms of their farming practices than French farms. As for the COP sector, Hungarian farming showed lower scale efficiency and worse management practices than French farming on average. The homogeneity of Hungarian farms decreased sharply in 2004 for dairy and in 2003 for COP, suggesting that a large part of farmers in this country were not able to adapt their practices to the new environment brought by EU accession.

Looking at the results with a common frontier showed that Hungarian farms were leading the technology in both dairy and COP sectors. It could have been expected, by contrast, that Hungarian farms would lag far behind French farms, as they might not have had 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 that, however, Hungarian farms have had access to technological improvement as much as French farms. This might be due to the presence of large corporate farms, but also to the higher public support received by Hungarian farms during this period (for example the PSE for milk were 57% in Hungary against 45% in the EU-15 in 2002) which could enable them to keep their technology up to date before the EU enlargement.

It could therefore be expected that the accession of Hungary to the EU in 2004 would increase even more Hungarian farms' technological superiority, as it enables its farmers to receive European subsidies, in the form of Single Area Payments (SAP). 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. As for French farms, they might need to reduce their input use (e.g. variable factors) on farm if they want to keep up with Hungary's competition.

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APPENDIX

Table 4: Yearly technical efficiency (TE) as average for the whole period 2001-2004; common frontier; results for the pooled sample (France+Hungary)

	Dairy farms (TF41)	COP farms (TF13)
Average TE under CRS	0.713	0.403
Average TE under VRS	0.750	0.434
Average scale efficiency	0.950	0.940
Number of observations per year	719	1,183