Impact of public subsidies on farms' technical efficiency in New Member States before and after EU accession

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Abstract— **This paper presents some results of a two-year (2006-2007) research project supported by the French Ministry of Research's funding program ECO-NET. One of the project's objectives was to investigate the determinants of farm technical efficiency in New Member States before and after accession to the European Union, and in particular the role of public subsidies on this performance variable. Four countries were considered: Hungary, the Czech Republic and Slovenia, who acceded to the EU in 2004, and Romania, whose accession was in 2007. The study found that subsidies had a negative impact on farm technical efficiency in Hungary over the period 2001-2005, in the Czech dairy corporate sector over the period 2000-2004, in Slovenia over the period 1994-2003, and in the Romanian crop sector in 2005.**

Keywords— **technical efficiency, farms, subsidies, Hungary, Czech Republic, Slovenia, Romania**

I. INTRODUCTION

This paper presents some results of a two-year (2006-2007) research project supported by the French Ministry of Research's funding program ECO-NET. One of the project's objectives was to investigate the determinants of farm technical efficiency in New Member States (NMS) before and after accession to the European Union (EU), and in particular the role of public subsidies on this performance variable. Four countries were considered: Hungary, the Czech Republic and Slovenia, who acceded to the EU in 2004, and Romania, whose accession was in 2007. Since accession, farmers in the NMS receive subsidies in frame of the Common Agricultural Policy; such subsidies are much higher than what farmers were given pre-accession in the frame of the national policies. It is nevertheless interesting to investigate whether national support, despite being low, enhanced farmers' efficiency, or had a negative influence due to a reduced effort and a waste of inputs.

Two types of methods have been used to measure technical efficiency, that is to say the ability to produce as much as possible with the least possible inputs at an existing technology: the parametric approach that relies on estimating a stochastic production frontier, and the non-parametric approach called Data Envelopment Analysis (DEA). The stochastic frontier method assumes that the production function includes two random errors, one of them being non negative and representing the technical efficiency (Aigner et al. [1]; Meeusen and van den Broeck [2]). With this method, determinants of technical efficiency are estimated simultaneously with the production function, the mean of the conditional distribution of this non-negative random term being parameterised in terms of several explanatory variables (Battese and Coelli [3]). In opposite to the stochastic frontier method, DEA is a deterministic method, meaning that the deviation from the frontier is fully attributed to inefficiency. This method does not require any distributional or specification assumptions and uses linear programming to construct the efficient frontier with the best observations from the sample itself, a farm's inefficiency being given by its distance to the frontier (Farrell [4]; Charnes et al. [5]). In the case of DEA, the determinants of technical efficiency are investigated in a second stage, where the efficiency

scores are regressed over a set of explanatory variables. A truncated regression is used instead of the standard Ordinary Least Squares when the efficiency scores' distribution is largely truncated at 1. Indeed, whether with a parametric or a non-parametric method, efficiency scores are measured between 0 and 1, the score 1 being attributed to a farm on the frontier (that is to say, fully efficient), and smaller scores indicating lower efficiency.

In the following, results for each country are presented in turn. A summary is then provided.

II. RESULTS FOR HUNGARY

The determinants of technical efficiency of Hungarian farmers were investigated between 2001 and 2005. This means that the effect of accession to the EU in 2004 on technical efficiency development could be analysed. Hungarian Farm Accountancy Data Network (FADN) data were used to build a balanced panel of 3,210 observations (642 per year). The pooled sample was used for the estimation. All legal types of farms were included in the sample (individual and corporate). The farms were large on average, with an average farm size of about 270 ha. The ratio of operational subsidies received by the farms to their total output was used as the subsidy determinant; dividing by output enables to disentangle the effects due to subsidies from the effects due to the size of the farm. The average farm subsidy to output increased from 0.1 in 2001 to 0.3 in 2005, showing an increased dependence on subsidies. A translog stochastic frontier was used, accounting for potential heteroscedasticity. Time variables were added to the stochastic production function in order to capture the possible technology change. In the determinants of technical inefficiency, a dummy taking the value of 1 for the years 2004 and 2005, and 0 for previous years, was included, in order to assess the effect of EU accession on technical efficiency.

Technical efficiency was on average 0.78 in the first year studied, 2001, and decreased until 2004, where it started to increase again up to 0.75 on average in 2005. This suggests that the EU accession had a favourable impact on Hungarian farms' efficiency. With the stochastic frontier approach, the estimated coefficients explain the cause of inefficiency in the model; thus determinants with a positive sign suggest an obstacle to efficiency, while a negative sign indicates variables that enhance efficiency. Results of the investigation of the determinants are presented in Table 1. Taken together, the parameter of the time trend (positive sign) and the parameter of the EU dummy (negative sign) jointly confirmed that pre-accession the efficiency was decreasing, starting to increase only after accession. The operational subsidies to output ratio had a positive influence on inefficiency, suggesting that public subsidies, before and after accession, prevented farms from being efficient.

Table 1. Hungarian farms n 2001-2005: Determinants of technical inefficiency calculated with a stochastic frontier

	Coefficient	t-value	Signifi-cance
Time trend	0.556	2.75	***
EU dummy	-1.369	-3.14	***
Company dummy	-1.823	-2.49	***
Region 1 dummy	-1.040	-3.26	***
Region 2 dummy	-0.673	-2.43	***
Land to labour ratio	5.339	4.83	***
Livestock output to total output ratio	-3.442	-3.24	***
Square of livestock output to total output ratio	3.582	2.93	***
Soil quality index	-1.684	-5.45	***
Operational subsidies to output ratio	**0.151**	**10.2**	***

*** 1 percent level of significance; ** 5 percent level of significance; * 10 percent level of significance

III. RESULTS FOR THE CZECH REPUBLIC

The determinants of farm technical efficiency in the Czech Republic were investigated for a sample of corporate farms specialised in dairy production. Data are from the Czech FADN for the period 2000-2004. The pooled sample over the period consists of 431 farms; it is an unbalanced sample (between 84 and 89 farms per year). A translog stochastic frontier was used, with account of heteroscedasticity. Farms in the sample had on average 360 dairy cows and produced

on average 2 million litres of milk per year. In the determinant analysis, the dependence on public support was proxied by the value of all subsidies, including both operational and investment subsidies; the latter could not be distinguish from operational subsidies in some years, and therefore the whole level of subsidies had to be included.

Results of the determinants of technical inefficiency are displayed in Table 2. Because technical inefficiency is calculated with the stochastic frontier approach, a positive sign indicates an obstacle to technical efficiency, while a negative sign indicates a favourable determinant for efficiency. Year dummies' coefficients are not significant, indicating that technical efficiency was not higher in 2004 (when the Czech Republic acceded to the EU) than in 2000-2003. Regarding the subsidies proxy, it is the only significant determinant of farm technical inefficiency. The positive sign of the coefficient indicates that public support received by dairy farms reduced their technical efficiency.

Table 2. Czech dairy corporate farms 2000-2004: Determinants of technical inefficiency calculated with a stochastic frontier

	Coefficient	t-value	Signifi-cance
Constant	-5.180	-4.85	***
Year 2000 dummy	-5.656	-0.77	
Year 2001 dummy	-0.729	-0.66	
Year 2002 dummy	-0.464	-0.51	
Year 2003 dummy	0.468	0.80	
Share of the farm's area not in Less Favourable Area	-0.414	-0.95	
Share of crop production in total agricultural production	-0.264	-0.14	
Limited liability company dummy	0.174	0.54	
Total operational and investment subsidies	**0.357**	**3.07**	***

*** 1 percent level of significance; ** 5 percent level of significance; * 10 percent level of significance

IV. RESULTS FOR SLOVENIA

The determinants of technical efficiency of Slovenian farms were investigated for the period 1994-2003, that is to say during preparation for the accession to the EU in 2004. Both the parametric stochastic frontier (with a Cobb-Douglas specification) and the non-parametric DEA (with a truncated regression in the second stage) methods were used. The data used were FADN data for individual family farming only. Due to the small number of farmers in the country, farm-level data are not released in Slovenia. Only averages per production branches are available. Data for 13 branches over 1994-2003 were used here, thus a total of 130 observations made the pooled sample. By size, Slovenian farms are relatively small: between 10 and 22 ha in the sample over the analysed period 1994-2003. Operational subsidies were included as a determinant of technical efficiency in the form of a ratio to total revenue, in order to capture size effects. The ratio was very low for all years, less than 0.04, except of a high increase in 2001 to 0.12, this higher support being given for preparation to the EU standards.

For the whole period studied 1994-2003, technical efficiency calculated with stochastic frontier and with DEA was on average 0.54 and 0.59, respectively. Results from both methods are comparable and consistent, and suggest substantial potential for technical efficiency improvement. The results regarding the determinants of technical efficiency are also consistent between both methods. They are provided in Table 3 for the stochastic frontier estimates and Table 4 for the DEA estimates. The determinants of technical inefficiency were investigated for the case of stochastic frontier model; therefore, in Table 2, a negative (positive) sign indicates a source of (obstacle to) technical efficiency.

Regarding the time trend variable, in both methodological approaches it indicates that technical efficiency has increased over time. As for the ratio of operational subsidies to output, its influence was negative. Thus, despite a very low level of the direct production budgetary support during the period studied, subsidies still had a negative effect on technical efficiency, by reducing farmers' efforts.

Table 3. Slovenian individual farms in 1994-2003: Determinants of technical inefficiency calculated with a stochastic frontier

	Coefficient	t-value	Signifi-cance
Constant	-0.110	-2.02	***
Time trend	-0.472	-4.62	***
Share of hired labour	-0.298	-0.95	
Share of rented land	-0.178	-1.29	
Share of marketed output	0.225	3.69	***
Herfindahl specialisation index	-0.263	-1.77	*
Production subsidies to revenue ratio	**0.214**	**5.27**	***

*** 1 percent level of significance; ** 5 percent level of significance; * 10 percent level of significance

Table 4. Slovenian individual farms in 1994-2003: Determinants of technical efficiency calculated with DEA

	Coefficient	t-value	Signifi-cance
Constant	0.870	3.33	***
Time trend	0.032	7.20	***
Share of hired labour	0.002	1.25	
Share of rented land	0.001	2.02	**
Share of marketed output	-0.006	-2.01	**
Herfindahl specialisation index	0.206	2.69	***
Operational subsidies to revenue ratio	**-1.090**	**-5.00**	***

*** 1 percent level of significance; ** 5 percent level of significance; * 10 percent level of significance

V. RESULTS FOR ROMANIA

The determinants of farm technical efficiency in Romania were analysed for the year 2005 for farms specialised in crop production, using FADN data. The final sample consisted in 319 farms; all legal forms were included in the sample, but there was a larger share of companies (only 4 percent of the farms were family farms). Farms were on average 770 ha of size. The method employed was DEA. Subsidies were included in the second-stage regression in the form of the amount per hectare of various types of subsidies.

Table 5 shows the results of the regression including two types of subsidies: subsidies given per crop output produced (as an amount per hectare of land) and subsidies given for the purchase of seeds and pesticides (as an amount per hectare of land). Other types of subsidies were tested, but did not bring any significant influence. Results indicate that output subsidies had a positive significant impact on farms' level of technical efficiency, while the opposite is shown for input subsidies. It suggests that the latter therefore gave incentives to farmers to use more inputs than they needed for their production, making their production process inefficient. By contrast, subsidies on crop production enabled Romanian farmers to increase their efficiency.

Table 5. Romanian crop farms in 2005: Determinants of technical efficiency calculated with DEA

	Coefficient	t-value	Signifi-cance
Constant	0.193	1.95	**
Family farm dummy	0.121	1.74	*
Region 1 dummy	0.235	2.25	**
Region 2 dummy	0.255	2.43	**
Region 3 dummy	0.232	2.27	**
Region 4 dummy	0.078	0.72	
Region 5 dummy	0.228	2.13	**
Region 6 dummy	0.163	1.48	
Region 7 dummy	0.311	2.55	***
Debt to asset ratio	0.018	3.45	***
Subsidies for crop output, per hectare	**0.00003**	**2.52**	***
Subsidies for seeds and pesticides purchase, per hectare	**-0.00056**	**-2.02**	**

*** 1 percent level of significance; ** 5 percent level of significance; * 10 percent level of significance

VI. SUMMARY

The determinants (including public support) of farms' technical efficiency were investigated for four NMS, for the following samples: farms for all production and legal types in Hungary over the period 2001-2005; dairy corporate farms in the Czech Republic over the period 2000-2004; individual farms

of all production types in Slovenia over the period 1994-2003; crop farms of all legal types in Romania in 2005. All samples were considered separately.

In line with previous studies incorporating a subsidy variable in their analysis of the determinants of farms' technical efficiency (Giannakas et al. [6]; Rezitis et al. [7]; Guyomard et al. [8]), this study found that subsidies had a negative impact on farm technical efficiency in Hungary (operational subsidies per output ratio), in the Czech dairy corporate sector (value of all subsidies received by the farms, that is to say operational and investment subsidies), in Slovenia (operational subsidies per revenue ratio) and in the Romanian crop sector (subsidies for seeds and pesticides purchase, per hectare). By contrast, the impact of subsidies on production (subsidies for crop output, per hectare) was found to be positive for Romanian crop farms.

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