AGRICULTURAL ECONOMICS EDUCATION IN UKRAINIAN AGRICULTURAL UNIVERSITIES: AN EFFICIENCY ANALYSIS USING DATA ENVELOPMENT ANALYSIS

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Abstract

Ukraine's transition from a centrally-planned to a market economy has had a profound effect upon its agricultural sector and agricultural universities. A substantial reduction in state financing has forced universities to adopt a range of survival strategies, with varying degrees of success. In this paper we use data envelopment analysis to examine the technical efficiency of 44 agricultural economics programs from 19 Ukrainian universities during the 2002/03 academic year. Our empirical results indicate wide disparities in performance, ranging from 36% to 100% technical efficiency. A second-stage analysis suggests that factors such as student demand, commercial activities and staff quality help explain a portion of this variation.

JEL Classification: I21, C14, Q16

Key words: higher education, Ukraine, efficiency, data envelopment analysis

1. Introduction

The transition from a centrally-planned to a market economy in the Ukraine has had a major impact upon the food and agricultural sector. These changes have created new conditions and challenges for the whole of the agricultural knowledge system. Of the various components and problems that comprise this development, this paper focuses upon agricultural higher education, and in particular upon the education of agricultural economists. Historically, Ukraine has had a system of agricultural higher education structured to satisfy the social and political needs of a centrally-planned agricultural sector. After the breakdown of the socialist system, the newly independent Ukraine tried to change the unfavourable situation in its educational system by establishing new universities and restructuring old institutes into new universities: this process saw a large increase in the number of programs offered in economics and business, and reflected the new market-orientated focus in the agricultural sector.

At present, agricultural education in the Ukraine encompasses 20 agricultural universities and 116 higher educational institutions with more than 190,000 students (with more than 130,000 in full-time education). Of these, approximately 50 per cent are studying in specialised programs in agricultural economics. The university system in the Ukraine (i.e., agricultural and otherwise) is currently facing a number of challenges. In particular, it faces a situation of constrained funding from the state, combined with student demand exceeding the supply of student places. At present, the number of students finishing primer school (i.e., high school) is roughly nine times smaller than the number enrolled in university. Hence, the demand for student places is expected to decrease substantially in coming years, with universities fiercely competing for new students (especially contract and foreign students). In the case of agricultural economics programs, the competition is expected to be particularly strong. This is a result of the diminishing importance of agriculture in the Ukrainian economy, combined with the expectation that agricultural economics programs will face tough competition with the large number of traditional universities (whose reputations have grown in recent years) that also offer economics programs.

Thus, the main question of interest is: Which agricultural universities will be able to better adjust to these new conditions and survive the so-called "post-reform" process successfully? The main aim of this study is to measure the relative academic performance of these agricultural economics programs and to investigate the factors that influence academic performance. Our empirical analysis involves the use of a non-parametric frontier methodology, known as Data Envelopment Analysis, which is used to measure the relative technical efficiency of 44 agricultural economics programs from 19 Ukrainian universities during the 2002/03 academic year. The results of this analysis should provide us with information on the current "state of health" of these programs, and provide information regarding which strategies have been successful in recent years, and hence might be best adopted in the future.

The remainder of this paper is organised into sections. In Section 2 the system of agricultural education in Ukraine is described in detail. In the third section some previous analyses of efficiency in

higher education institutions are reviewed, while in Section 4 the efficiency measurement techniques used in the study are outlined. The data and model specification used in the empirical analysis is described in Section 5, with the empirical results discussed in Section 6. Finally, some concluding comments are made in Section 7.

2. Agricultural Education in Ukraine

2.1. Agricultural higher education during the Soviet period

Before the Soviet period, Ukraine had a well-established, high quality system of higher education in agriculture, with long-established historical traditions. This system was further developed and adjusted during the Soviet period according to the needs of central planning, and specifically, according to the objectives of Communist Party of the USSR, to maximise agricultural production and achieve food security. Ukraine played an important role in the agricultural programme of the Soviet Union because of its rich natural resources[1] and a climate well-suited for agricultural production. Furthermore, the agricultural education system in Ukraine produced some outstanding results (Csaki, 1999).

The educational system in agriculture in the Ukraine in the pre-reform period can be characterised as follows (Csaki, 1999, Finnikov 2002, Nikitin *et al.,* 2001):

- Agricultural higher education was entirely planned, controlled, and financed by the Ministry of Agriculture of Ukraine. Professional and academic quality was at times subordinated to quantity needs, and institutions and training programmes were specialised to serve these manpower needs of the planned economy. Enrolment numbers were centrally-determined by the manpower needs of the socialist economy, which were based on forecasts by the Ministry of Agriculture;
- Students were provided with a five-year educational qualification known as “Specialist”.
- Higher educational programmes in agriculture were, and still are, overly-specialised, focusing on training for very specific professions.
- Agricultural education concentrated on increasing primary agricultural production. Teaching objectives tended to focus on maximising production, with little regard to economic efficiency, product quality, environmental consequences, or consideration of consumer demand for products.
- Most research activities were separated from the universities and were carried out by the state research institutes, which were managed directly by the Ministry of Agriculture or through the Academy of Agricultural Sciences of Ukraine.

2.2. The impact of the breakdown of the former Soviet Union

As stated in the introduction, higher education in the Ukraine faced a number of changes after the achievement of independence in 1991. To transform the old educational system, independent Ukraine adopted the Anglo-Saxon educational model by including academic degrees such as bachelor's and master's, as well as tuition fees. Overall, the key changes in the system of higher education in Ukraine may be summarised as follows:

- The introduction of four accreditation levels for higher education institutions (and the diplomas of their graduates), where levels I-II are for technical schools and colleges and levels III-IV for academies and universities.[2]
- The removal of Communist ideology from the teaching programs.
- Higher education institutions received more freedom in determining the types of courses offered and their content.
- A change in the structure of specialist training in a number of professions towards a significant increase in the number of graduates with skills in economics and management.

[1] Ukraine contains about 25 per cent of the world's black soils called “chernozem”.
[2] For details about different accreditation levels, see Finnikov 2002.

- The establishment of a wide network of private higher education institutions of different accreditation levels.
- The diversification of financial sources of higher education funding, with increased private funding in particular.

At present, agricultural education in the Ukraine involves 20 universities and academies[3] at the III-IV level of accreditation, plus 116 higher educational institutions at the I-II level of accreditation, plus their branches, which includes 20 colleges and 70 technical colleges. The analysis in this paper concentrates on higher educational institutions at the III-IV level of accreditation. This is partly due to data limitations, but also because of the significant structural and financial differences between these two groups of institutions[4].

In the 2002/03 academic year, more than 190,000 higher education students were studying in agricultural programs in the Ukraine, with more than 130,000 of these in full-time education. This is a large number relative to the population size in the Ukraine (49 million). By comparison, Germany had about 39,000 agricultural students relative to a population size of over 82 million. However, the number of employees in German agricultural sector is much lower than in Ukraine. Approximately half of the 130,000 full-time students were fee-paying students. Almost 12,000 students graduate each year from agricultural higher educational institutions at the III-IV level of accreditation (full-time students). However, recent surveys show that for most of them it is not easy to find a job in agriculture.

Reforms in the agricultural sector led to a reduction in the number of employees in agricultural enterprises over the last decade. The number of agricultural enterprise employees has reduced from 4,881,000 people in 1990 to 2,131,000 in 2001 (State Statistics Committee of Ukraine, 2002). However, this reduction in the number of agricultural enterprise employees did not result in a corresponding labour outflow from the agricultural sector and, therefore, resulted in increased unemployment in rural areas. This was due to a number of factors. First, in many cases unemployment was compensated by increasing self-employment on small farms, in spite of the low efficiency and low income of these farms. Second, the reduction in incomes and social support expenditure (e.g. lack of medical help to deal with tuberculosis, etc.) led to a natural depopulation.

As a result, the number (and average quality) of applicants to agricultural programmes has been declining in recent years. Many students choose to study agriculture, or especially agricultural economics, because of refusals from other non-agricultural universities or because of a lack of financing for fee-required study. It is obvious that the agricultural education in Ukraine is undergoing a profound crisis. This crisis is the result of constraining limitations on available funding and of major difficulties in adapting to a radically changing environment. The most important responses to this situation are as follows:

- The demand for graduates of traditional agricultural higher education has declined significantly. Most of the large farms are in serious financial difficulties and are not able to pay salaries for educated specialists.
- The state has consequently reduced the budgetary resources for the agricultural education system. The decline of state financing in some universities has been up to 80 per cent relative to the pre-reform period, which has led to individualised solutions. Universities have started special tuition-based programmes and have used available resources such as buildings and land for commercial gain.
- During the last decade the average monthly wages in agriculture compared poorly relative to other professions. Also, gross agricultural production has been constantly decreasing, to a level that is now approximately 60 per cent of the 1990 level. This decline is primarily due to substantial reductions in total factor productivity (Lissitsa and Odening, 2005).

[3] The differences between academies and universities are negligible, but academies are more specialised than universities.

[4] For details, see Ministry of Agricultural Policy of Ukraine (2002).

3. Education efficiency measurement

In the scientific literature, analysis of the performance of educational institutions is not new. Since the publication in the United States of "A Nation at Risk"[5] in April 1983, the relationship between educational resources and university outcomes as well as the search for measurable standards for academic performance has been a major area of study among economists and education researchers worldwide. Among them is a long list of attempts at estimating educational production functions, with the aim of improving the efficiency of school education through an improved understanding of the underlying production relationships.

Institutions of higher education in several countries have also been the subject of efficiency analyses in recent years (e.g. Ahn *et al.,* 1988; Cohen 1989, Johnes and Johnes 1995; Lovell *et al.,* 1994, Sarafoglou and Haynes 1996; Sinuany-Stern *et al.,* 1994; Tomkins and Green 1988, Carrington *et al.,* 2004, Athanassopoulos and Shale 1997, Taylor and Harris 2002, Mcmillan and Datta 1998). However, to our knowledge, no study has been published which investigates efficiency in higher education in transition countries of Central and Eastern Europe.

The analyses of efficiency in higher education have basically taken three different approaches: a university level approach, where the unit of observation is the institute of higher education itself (Johnes, 1996; Coelli, 1996, Carrington *et al.,* 2004); a subject level approach, where the unit of observation is a department or educational programme within the institution (Johnes and Johnes, 1993; Colbert *et al.,* 2000); and an individual level approach, where the unit of observation is the individual student (Smith *et al.,* 2000; Rodgers and Ghosh, 2001; Johnes, 2003).

Various methodological approaches have also been applied to measuring university efficiency, the most commonly used techniques being parametric methods like Stochastic Frontier Analysis (SFA) and non-parametric methods like Data Envelopment Analysis (DEA). Compared with SFA, DEA has the advantage that it does not require any assumption about the functional form of the technology, plus it provides valuable information on peer sets. SFA, on the other hand, has the advantage that it attempts to accommodate the effects of random noise in the data. In this paper we use the DEA traditional model and the super-efficiency model for the efficiency analysis of agricultural economics programmes in Ukrainian agricultural higher educational institutions, which makes it possible to investigate the sensitivity of our results.[6]

One of the earliest papers to use DEA as a tool to analyse efficiency of universities is that by Rhodes and Southwick (1986), which investigated differences between the performance of public and private higher educational institutions. The input variables chosen were the number of full professors, number of associate professors, number of assistant professors, dollars spent on maintenance, and dollars spent on libraries. The output variables were undergraduate enrolments, graduate enrolments, bachelor's degrees, master's degrees, doctoral degrees, and research funds. The efficiency scores of this study indicated that public institutions are less efficient than private ones. Their conclusion was that since public universities depend on taxes for a majority of their funding, they have less motivation to be efficient with available inputs and hence behave differently than their private rivals.

Coelli (1996) studied the relative performance of 35 Australian universities. The study involved the construction of three separate models: one for the administration sectors; one for the academic sectors; and one for universities as a whole. The university and academic models shared the same output variables of weighted student numbers and a research publication index (also weighted by type). In the administration model, total staff numbers replaced publication index. Total staff numbers also appeared as an input in the university model. Other inputs used across the three efficiency models were non-staff expenses, other expenses, other administration costs, and administration staff. A second-stage regression

[5] After studying the American education system, the National Commission on Excellence in Education published an alarming federal report entitled: "A Nation at Risk: The Imperative for Educational Reform". This report claimed that American "students were not studying the right subjects, were not working hard enough, and were not learning enough. Their schools suffered from slack and uneven standards. Many of their teachers were ill-prepared", (for details see US Department of Education, www.ed.gov).

[6] See Coelli, Rao and Battese (1998) for further discussion of the relative merits of SFA and DEA.

analysis found no significant relationship between efficiency and per cent of external enrolments or proportion of part-time enrolments.

McMillan, M. L. and D. Datta (1998) report in their paper on the results of using DEA to assess the relative efficiency of 45 Canadian universities. Outcomes are obtained from nine models involving different specifications of inputs and outputs. Tobit regression analysis of the efficiency scores used in the second stage of analysis for identifying further determinants of inefficiency was relatively unsuccessful. There is some evidence, however, that competition from nearby universities, program specialisation and, to a greater extent, total enrolment (although the DEA already allowed for economies of scale) increase efficiency. The authors observed that the choice of variables included in the DEA can have a significant effect upon the results obtained.

Colbert, Levary and Shaner (2000) used DEA to determine the relative efficiency of 24 top-ranked US MBA programmes. Efficiency scores were determined using three output sets for the MBA programmes: output measured as student satisfaction, output as measured recruiter satisfaction and output that measured both. Also, three foreign MBA programmes were compared with the top-ranking US MBA programmes. The analysis indicated that all three foreign programmes and only one US program were efficient. The results of this performance study also highlight the importance of the inputs and outputs used in determining relative efficiency.

Carrington, Coelli and Rao (2004) investigated the efficiency and total factor productivity (TFP) growth of Australian universities during the 1996-2000 period using DEA and the Malmquist TFP Index. Their DEA model included two outputs, weighed publications and weighed students, and one input, operation costs. The results showed large differences in performance between universities. In the second stage of study, the variations in efficiency were explained using Tobit regression analysis. However, only two environmental variables, location and the proportion of rural and remote students, had a significant influence on technical efficiency. The results also suggest that the educational sector is relatively efficient and the rate of total factor productivity growth was superior to most other sectors of the Australian economy.

4. Methodology

According to Farrell (1957), efficiency is defined as the actual productivity of a firm in relation to its maximal potential productivity. The maximum productivity, which is also called the ”best practice”, is defined by the production frontier. Thus, efficiency measurement involves measuring the distance from the observed data point to this frontier. Given access to suitable data on a number of firms within a particular industry, the production frontier can be estimated in several ways, either parametrically - for example, through SFA - or non-parametrically, through DEA. In this paper, the latter approach is used.

The mathematical exposition of the DEA model, which follows, is based upon Coelli, Rao and Battese (1998). DEA can be either input-orientated or output-orientated. In the input-orientated case, the DEA method defines the frontier by seeking the maximum possible proportional reduction in input usage, with output levels held constant. In the output-orientated case, the DEA method defines the frontier by seeking the maximum possible proportional expansion in output, with input levels held constant. The two measures provide the same technical efficiency scores when a constant returns to scale (CRS) technology applies, but are generally unequal when variable returns to scale (VRS) are assumed. In this study, an input-orientation is chosen because it would be fair to assume that in the Ukrainian education sector, the agricultural universities have greater control over input quantities relative to output quantities.

If one has data for N educational programs in a particular time period, the linear programming (LP) problem that is solved for the i-th educational programme in an input-orientated DEA model is as follows:

$$\min_{\theta,\lambda} \theta,$$
$$\text{st} \qquad -y_i + Y\lambda \geq 0,$$

$$\theta x_i - X\lambda \geq 0,$$
$$\lambda \geq 0,$$

where θ is a scalar and λ is a $N \times 1$ vector of constants. The value of θ obtained will be the efficiency score for the i-th educational programme. It will satisfy: $\theta \leq 1$, with a value of 1, indicating a point on the frontier and hence a technically-efficient programme.

The above DEA model can be expanded to allow for a production technology with variable returns to scale (VRS). This is desirable if the analysed educational programs vary according to their size. This is achieved by introducing the convexity constraint, $N1`\lambda=1$ (where $N1$ is a vector of ones), which essentially ensures that an inefficient programme is only "benchmarked" against programmes of a similar size[7]. In this case, the CRS technical efficiency score can be presented as a product of VRS technical efficiency and scale efficiency.

According to Lovell (2004) and Lovell and Rouse (2003), an important extension of DEA has been the creation, during the past decade, of 'super-efficiency' DEA models. In contrast to traditional DEA models, the super-efficiency DEA model excludes each observation unit from its own reference set, so that it is possible to obtain efficiency scores that exceed one. In this paper the model of Andersen and Petersen (1993) is used for the ranking of agricultural economics programmes in Ukraine and for explaining the efficiency scores using regression analysis.

Mathematically, the super-efficiency model is identical to the conventional DEA model, except that the unit under evaluation is not included in the reference set. The super-efficiency score of an inefficient university will not differ from the standard efficiency score because an inefficient university cannot be a reference university of itself. On the other hand, an efficient university could get a super-efficiency score larger than one, where a high super-efficiency score indicates the university is well above its peers and hence should be highly ranked. However, a very high score may indicate that a university is highly specialised in research or in education and therefore not comparable to other universities in the sample data. Hence, the concept of super-efficiency also helps one to identify such universities. Additional details about the used super-efficiency model can be found in Andersen and Petersen (1993).

5. Model Specification and Data

The education efficiency model attempts to mirror the core missions of higher educational institutions: teaching and research. As outlined in Section 3, previous authors have used a variety of input and output measures. Most of these studies observed that specifying the inputs and outputs for use in an analysis of university performance was a difficult task. The specification of this DEA model has been constrained by the factor, as per description in Coelli (1996), that DEA studies suffer from a problem which is similar to the "degrees of freedom" in statistics. This means that with a small sample size, one can only consider a small number of inputs and outputs. The variables chosen for the DEA analysis are described in Table 1.

[7] More about increasing and decreasing return to scales see Coelli *et al.*, (1998:150).

Table 1: Variables used in the DEA model[SoE1]

Outputs	Description	Inputs	Description
Higher Education	Weighted number of students: *1. studying financed through the state:* - Full-time students - 1.0 - Part-time students - 0.5 *2. studying financed through fees* - Full-time students - 1.0 - Part-time students - 0.5	Teaching	Total number of salaried staff Number of full positions available in every program
Research	Weighted index of scientific work *1. monographs published* - in international publishing houses - 2.0 - national publishing houses - 1.5 *2. articles published:* - in international journals - 1.0 - in national journals - 0.5 *3. paper presented at:* - international conferences – 0.7 - countrywide conferences - 0.5 - regional conferences, university's own events - 0.3	Overhead costs	Overhead costs in Ukrainian Hryvnia (without teacher salaries) including: *1. educational and research process:* computers, library, internet access, etc., measured in Ukrainian Hryvnia 2. *other running costs* including maintenance of buildings, cars, etc., measured in Ukrainian Hryvnia

In this study, the number of students is used as an output of the educational process. This measure is a weighted number of full-time and part-time students whose studies are supported by the state or who pay fees (see Table 1). One could argue that this measure should have also been weighted in some way to reflect the degree of diversification between bachelor's and master's students. However, the higher education system in Ukraine is still undergoing a restructuring process at present, and hence not all agricultural universities have introduced the Anglo-Saxon system of education including bachelor's and master's degrees.

Most studies of university performance also include some kind of research variable as a university output. However, measuring research has several difficulties. Research funds, citations, number of publications and peer review assessments were some of the research measures used in other studies. For discussion of the relative merits of these measures see Carrington *et al., (*2004), where the dangers of using *input* measures such as research funds as an *output* indicator are discussed in some detail. In this study, the research variable used is an index of weighted scientific publications and presentations. However, several implicit assumptions underline these measures. In particular, number of publications is assumed to reflect the research efforts of a particular observation year. But the measure predominately reflects research that has been done in previous years. Thus, articles published in the observed period 2002-2003 would arguably provide a better indication of research conducted in 2000-2001 than weighted information for that time period. But such information is not available in the data set. Carrington *et al.*, (2004) discuss this issue and use Spearman rank correlations to measure the degree of association between weighted publications per academic year and find that their publication index is relatively constant over a five-year period. Here, it is assumed that the research effort is also fairly constant from year to year, and hence the publications index should be a reliable measure.

Most previous studies of university efficiency have included input variables for academic staff (either number of staff or salary expenditure) and an overhead or administration expense variable. In this study we have decided to use total salaried staff[8] (or number of full staff positions) as an input variable. This has been favoured over the two alternative measures of staff salaries and number of actual teachers

[8] Under the assumption that all positions are occupied.

because of special conditions in the Ukrainian public sector. First of all, during the transition period most Ukrainian universities, as well as other public institutions, were not able to pay staff salaries due to a lack of finances (Cramon-Taubadel 2001, Lissitsa 2002). Secondly, the number of actual teachers may not reflect the real situation at universities because quite a few of them also have part-time jobs outside of the university. One disadvantage of the selected staff input variable is that the number of full positions does not reflect the quality of staff, different staff profiles, nor the contracting out of services. However, some of these issues are addressed in the second stage of analysis, where some teaching quality indicators are included. The second input variable is defined as overhead costs or overheads measured in UAH[9], which includes all operating costs (excluding salaries).

Data were available for 44 programs in agricultural economics and related fields from 19 Ukrainian agricultural universities during the 2002-2003 academic year. One agricultural university (Poltava) was not included in the analysis due to missing data. Also, some agricultural economics programs from these 19 universities were excluded because of incomplete data. This was mostly because some universities established new programs in agricultural economics, such as management or marketing, only a few years ago and are yet to have any students graduate. Furthermore, it should be noted that some non-agricultural universities, like the National Economic University in Kiev or the Technical University in Chernihiv, offer educational programs in agricultural economics. However, unlike most agricultural universities, they are not financed by the Ministry of Agricultural Policy. Therefore, the data were not available for this study.

6. Empirical Results

6.1. Efficiency scores

Distributions of CRS technical efficiency (TE-CRS), VRS pure technical efficiency (TE-VRS) and scale efficiency (SE) of the 44 educational programmes are provided in Figure 1. Recall that SE=TE-VRS/TE-CRS. The TE-VRS measure indicates the possible efficiency improvement that can be archived without altering the scale of operations. Hence, it can be viewed as a short run efficiency measure (Coelli 1996). The scale efficiency measure requires the university to increase or decrease its scale of operation and hence should only be viewed as a long run measure. Figure 1 illustrates a large spread of the CRS and VRS efficiency scores. The CRS mean equals 0.584, and the standard deviation is 0.213 (VRS 0.669 and 0.209, respectively). There is a small group of ”star performers” with efficiency values between 0.9 and 1.

A comparison of the technical efficiencies and the scale efficiency results indicates that the former has the greater impact on productivity. The distribution of scale efficiencies shows that most of the university programs are scale efficient or are operating close to the optimal scale. Thus, technical, not scale improvements appear to be the avenue to relative efficiency gains. It should be also noted that 27 (61 per cent) of agricultural programmes exhibit increasing returns to scale, implying they are too small; 12 exhibit (27.3 per cent) decreasing returns to scale, implying they are too big, and only 5 are operating at the **technically optimal scale size** (TOPS). Interestingly, all programmes of the biggest Ukrainian agricultural university in Kiev, which has approximately 20,000 students in agriculture, are operating either at an optimal scale or with decreasing returns to scale.

[9] Exchange Rate from 12th July 2004: 1 Euro (EUR) = 6.044 Ukrainian Hryvnia (UAH).

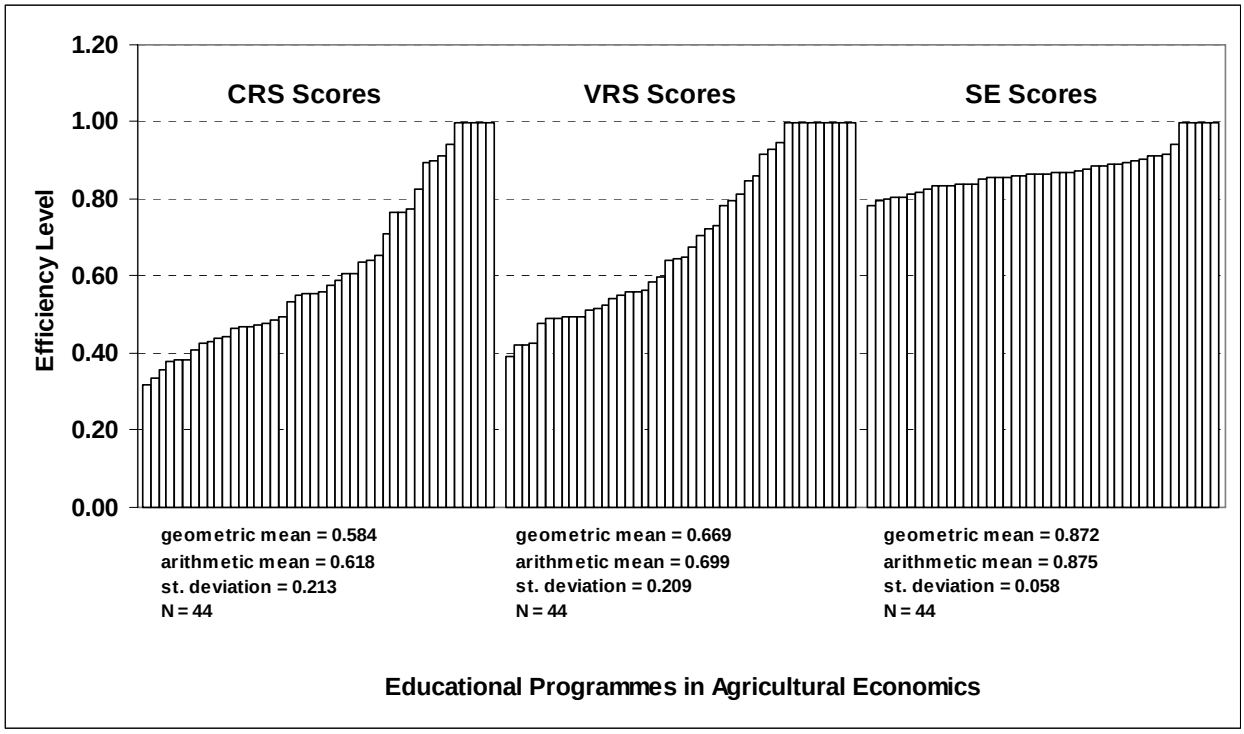

Figure 1: Distribution of efficiency scores

In order to answer the question, how comparative are the agricultural universities in terms of education and research in agricultural economics in Ukraine, the efficiency scores from individual programs have been aggregated using geometric means to construct aggregate scores for each of the 19 universities. The results of TE-CRS, TE-VRS and SE are summarised in Table 2. The results indicate a large diversity of performance among the universities. There are three universities defined as "star universities", which include the National Agricultural University in Kiev, the Sumy National Agricultural University, and the Kharkiv State Agricultural University. It is not surprising that these three universities have leading positions in terms of their technical efficiency. These universities have been accredited in the recent past by the Ukrainian Government with the titles "National" as acknowledgment for their successes in teaching and research. Thereby, they receive from the state, for example, *inter alia* about 50 per cent[10] more in financing for teacher salaries.

[10] See site of the President of Ukraine www.president.gov.ua

Table 2: Aggregated efficiency scores among Ukrainian agricultural universities

	Universities	**programs**	**TE-CRS**	**TE-VRS**	**SE**
1	Vinnitsya State Agricultural University	2	0.55	0.55	0.99
2	Lviv State Academy for Veterinary Medicine	1	0.59	0.60	0.99
3	Zhytomyr State Agro-ecological University	3	0.60	0.64	0.93
4	Dnipropetrovs'k State Agricultural University	2	0.45	0.48	0.94
5	Bila Tserkva State Agricultural University	5	0.59	0.93	0.63
6	Lugansk State Agricultural University	2	0.48	0.51	0.94
7	Crimea State Agricultural University	2	0.57	0.62	0.93
8	Lviv State Agricultural University	2	0.55	0.56	0.97
9	Mykolayiv State Agricultural University	2	0.46	0.49	0.94
10	Odessa State Agricultural University	2	0.36	0.48	0.74
11	Podilya State Agro-technical Academy	2	0.35	0.41	0.86
12	Tavriya State Agro-technical Academy	2	0.52	0.54	0.97
13	**Sumy National Agricultural University**	***2***	***0.84***	***0.85***	***0.99***
14	Uman State Agricultural Academy	2	0.66	0.69	0.95
15	**Kharkiv State Agricultural University**	***2***	***1.00***	***1.00***	***1.00***
16	Kharkiv State Zoo-veterinary Academy	1	0.36	0.73	0.49
17	Kharkiv State Technical University for Agriculture	3	0.71	0.86	0.83
18	Kherson State Agricultural University	2	0.58	0.69	0.85
19	**National Agricultural University Kiev**	***5***	***0.82***	***0.84***	***0.97***
	Mean	***44***	***0.58***	***0.67***	***0.87***

6.2 Ranking of best programs

In this section we rank the programs, using super-efficiency analysis, to allow us to identify the top performers and hence attempt to analyse their chosen strategies. Super-efficiency scores are derived using the VRS model. The ten highest-ranked programs are listed in Table 4.

Table 3: Ranking of top ten programmes

Rank	Programme	University	Super Efficiency score	Times used as peer	Ratio student-teacher	Ratio research-teacher
1	Accounting and audit	Sumy	2.34	21	31.4	3.96
2	Economics of enterprise	Kiev	2.12	3	9.2	4.55
3	Management of organisations	Kharkiv SAU	1.26	18	28.0	3.07
4	Management of organisations	Bila Tserkva	1.22	20	33.0	0.81
5	Accounting and audit	Kharkiv SAU	1.22	10	31.7	2.35
6	Finances	Bila Tserkva	1.22	13	21.2	1.00
7	Economics of enterprise	Kharkiv TU	1.11	4	15.8	3.78
8	Management of International Economic Activities	Kiev	1.10	8	12.3	4.91
9	Accounting and audit	Kharkiv TU	1.03	5	21.3	3.88
10	Management of International Economic Activities	Bila Tserkva	0.95	0	13.0	0.85

Among the ten most efficient programmes are representatives from five universities. The analysis of the ratios derived from the DEA inputs and outputs of the ten best programmes shows that the different universities have chosen various "survival" strategies, including those that could be described as "specialisation only in education" and "consolidation of research and education". Most programs chose the strategy of getting more students into the university, which means that the students study on a contractual basis and bring more money to the university. It is an arguable point whether this strategy is the right one in the long run, particularly if the number of potential future agricultural students is presumed to fall. However, the student-teacher ratios are, internationally, not as high and are comparable with some developed counties with higher educational levels. For example, in 2003 at the University of Queensland, the ratio equals 24.5 students in commerce and management per teacher, a number which in Australia averages 31.5 (Australian Vice-Chancellor Committee, 2004[11]). The strategy of the University in Kiev goes in the other direction – less students and more research activities. The selection of contract students is constrained by high study fees. Kiev offers student places for approximately 3,500 US$ per year, which is about three times more than in other agricultural universities, for example Sumy (ca. 1,200 USD). The possible explanation for that could be that Kiev, as Ukrainian capital, has got privileged living standards in Ukraine with a huge number of very rich people and politicians.

The DEA analysis also provides information on the "peers" of programmes with low efficiency scores. The frequency by which efficient universities are used as comparators of inefficient ones can be used as benchmarking criterion. Universities or programmes with low frequency of use as comparators generally have extreme operating or size characteristics and hence should not be used as role models to be emulated by inefficient programmes. The frequencies being used as a peer for less efficient programs are derived from the VRS super-efficiency analysis and are presented in column 4 of Table 3. Of these ten top programs, nine were selected as peers, with the largest count belonging the accounting program at Sumy, with 21 peer citations.

6.3 Factors influencing efficiency

The above DEA analysis evaluates the relative efficiency of the programs, but are there other "environmental" factors (i.e., exogenous factors not under the control of management) that may potentially influence performance? To address such questions, researchers frequently seek to explain the efficiency scores obtained from DEA analysis using regression analysis (Lovell *et al*., 1994, McMillan and Datta 1998, Carrington *et al.*, 2004). Because the efficiency scores of traditional DEA models are censored at one, OLS regression could produce biased and inconsistent estimates. As an alternative

[11] http://www.avcc.edu.au/index.asp

methodology, the Tobit regression model with censored depended variable has been chosen in several previous studies for the second stage analysis (see McMillan and Datta, 1998, Carrington *et al.*, 2004). In this study we avoid this censoring problem by using the super-efficiency scores which are not bounded by one. Hence we can apply OLS to these data.

Various factors that might affect the (in)efficiency of a university or program may be considered. In this study we have identified ten variables that we suspect may help explain variations in efficiency scores. These include student quality; location; administrative tasks; business performance; education quality, and staff quality.

Student quality: Ukrainian universities have different options for improving student quality. At one end of the continuum, traditional universities such as the National Agricultural University of Ukraine in Kiev can set high entry requirements for state financed students and high fees for contract students, thereby making themselves quite selective with respect to their student intake. At the other end, the less selective institutions, mostly in small towns, have limited influence over student quality.

Location: Universities located in rural regions of Ukraine often struggle to attract students because of the lower quality of life and the lack of social activities. Academic salaries are often lower in rural universities compared to their metropolitan counterparts. As a consequence, the metropolitan universities often "poach" the best researchers from “rural” universities.

Administrative tasks: Part-time students create additional administration costs for universities relative to full-time students because they take longer to complete a degree. However, part-time students often need lower capital costs because less capital equipment is required for their education. Therefore, the net effect that part-time students have on the performance of universities is unclear because savings in capital costs may outweigh the additional operating costs.

Business performance: In the past several years, the agricultural educational community in Ukraine has been fighting to maintain minimum operational costs, or in many cases, has been fighting for survival. Universities started special tuition-based programmes for foreign and external students and must often rent buildings or theatre lecture spaces to the private sector. Many educators and researchers have taken part-time jobs, and research programmes at these universities have also been refocused toward topics of more practical or local interests. Some of the researchers have established private companies or consulting firms. On one hand, the impact of business activities on efficiency may be negative because resources are diverted to these activities. On the other hand, the public funds remain limited; therefore, partial cost recovery is necessary. Otherwise the highly skilled staff will quit for better-paying jobs outside academia. Thus, the net effect is unclear.

Education quality: Education quality has had several changing perspectives over time. Among the several studies related to education and its quality, some matters that can be pointed out are: the achievements of students, institutionally-available resources, teacher-student ratios, successful job acquisition after study. Thus, quality in higher education is a curricular matter, and is not easy to define, or can be defined from several points of view. In some countries, such as Australia, the whole division in the Department of Education, Science and Training[12] is occupied with the quality of education and its control. In its contracts with them, the Ukrainian education system does not apply an evaluation procedure for quality control. There is also no feedback concerning the faculty's professional performance. It was not easy to find the indicators for education quality. The idea of using teacher-student ratio as a quality indicator in this study was rejected because it would be a partial productivity measure, and the relationship would be unambiguous. As indicators for education quality, the ratio of graduates with honours diploma to all graduates and the ratio of graduates who obtained a job in 2002 to all full-time graduates were used. These variables are expected to be positively related to efficiency.

Staff quality: The majority of Ukrainian professors were educated in the Soviet system and continue to support old-fashioned principals, both in research and educational process. The mean age of professors is about 65 years. According to the Ukrainian legislation, only professors who are state officials (e.g. rectors or vice-rectors) are required to retire at the pension age: at 60 for males, at 55 for females. As a consequence, more than half of the faculty members are in their seventies. One could argue that elderly staff have the advantage of accumulated knowledge and experience. On the other hand, young staff can perhaps absorb more updated information from international scientific resources and have better access to

[12] Official web site of the Australian Department of Education, Science and Training: http://www.dest.gov.au/

those, particularly through a knowledge of the internet and languages. Consequently, the influence that a ratio of pensioners to all staff members has on performance is uncertain.

The OLS estimates of the regression model where VRS super-efficiency scores are regressed against ten variables are reported in Table 4. This model explains a significant portion (about 46 per cent) of the variation in university programmes in agricultural economics. Five of the ten variables have estimated coefficients that are significantly different from zero at a ten per cent level. The coefficient associated with the number of applications per available student place is positive and significant. This could reflect the possibility that the above average quality of students entering highly competitive programs make them easier to teach (i.e., require fewer resources) relative to students with lesser abilities. The coefficient of the enrolment variable is negative and significant, suggesting that technical efficiency increases as the size of program decreases. Given that the model involves VRS scores, this is not an indication of scale inefficiency. It may be a consequence of the better funding levels and thus lower student/staff ratios in some traditional universities like Kiev or Kharkiv, and hence could reflect some program quality differences not captured in the output measures. The other variables that have a significant impact on the university programmes' performance are staff quality and business performance indicators. The positive impact of staff quality (i.e., pensioner ratios) is most likely due to the accumulated knowledge of these senior staff and their publishing abilities. The two business performance indicators have conflicting signs. The funds ratio variable is negative, which supports the notion that business activities result in a diversion of resources away from the core teaching and research activities. However, the positive value of the number of consulting contracts variable goes against this argument. Perhaps these contracts tend to be larger in nature and hence require the hiring of additional staff members to conduct the work. However, this is only supposition. Further analysis of these issues is required before more definitive comments can be made.

Table 4: Regression results for VRS superefficiency scores

Variable	Unit	Regression coefficient	Standard error	*t*-Ratio	*p*-Value
Constant	-	-0.335831	0.246061	-1.36482	0.172308
Student quality					
Number of applications per full-study place	No.	0.028700	0.014637	1.95788	0.050243
Study fees in 2002	UAH	0.308000	0.000028	1.07280	0.283363
Enrolment in the current year	No.	-0.000921	0.000439	-2.09816	0.035891
Location					
Location	dummy	-0.119000	0.092573	-1.28514	0.198745
Administrative tasks					
Ratio of full-time students to all students	%	-0.303528	0.336498	-0.90202	0.367046
Business performance					
Ratio of non-budget founds to all programme founds	%	-0.705601	0.321265	-2.19632	0.028069
Number of consulting contracts	No.	0.000175	0.000078	2.23177	0.025630
Education quality					
Ratio of graduates with honour diploma to all graduates	%	0.608773	0.495657	1.22822	0.219366
Ratio of graduates who obtained a job in 2002 to all full-time graduates	%	-0.640145	0.472116	-1.35591	0.175129
Staff quality					
Ratio of pensioners to all teachers	%	1.146990	0.498559	2.30060	0.021414

7 Summary and Conclusions

The transition from a centrally-planned economy to a market economy has proceeded at a pace slower than expected and with many sacrifices. One of the most problematical sectors is the agricultural sector. Agriculture constituted 25 per cent of the GNP until 1990, was considered the most important sector of the Ukrainian economy, and was regarded as a potential driving force for economic growth. Despite the promising beginning, thirteen years after Ukraine became independent, disillusionment has settled in. A drastic decline in agricultural production, high unemployment, high mortality rates in rural areas, and high migration from country regions are a direct indication of weak development in this sector.

As a consequence of these changes, agricultural higher educational institutions must increasingly compete for students and non-state funding. The purpose of this paper is to apply Data Envelopment Analysis in examining the relative efficiency of agricultural economics programmes in Ukrainian universities. The empirical results show a wide spread of efficiency scores among agricultural economic programs, with technical inefficiency being a more important factor than scale inefficiency.

A small group of star performances were identified. They are the National Agricultural University in Kiev, the National Agricultural University in Sumy and the State Agricultural University in Kharkiv. It appears that these universities' management have chosen the right survival strategies and pursued them during the transition period. Finally, a second stage regression analysis indicates that staff quality, student quality and business performance can partly explain the observed differences in technical efficiency scores across the various programs. The DEA results suggest that the changes in the specified attributes of the most Ukrainian agricultural universities, that need to occur for the agricultural economics programme to become efficient with respect to its reference set or better to say to survive. Due to the dropping number of students in agriculture it would be absolutely necessary to improve the research performance as well as closed cooperation with research departments agribusiness in the most universities. That could be done for instance with the cooperation of research institutes of Academy of Sciences or with traditional universities.

The DEA approach used in this study would be helpful for university administrators not only for comparing own programme or university with other but also could help to identify the ways by which the efficiency level of each educational programme or academic unit can be optimised. That means also that several managerial implications emerge from the use of the DEA model. The DEA model can also provides information about the courses that contribute to the relative inefficiency scores. Knowing the reasons why an academic unit is inefficient (i.e. averaged older of professors or high tuition fees) would provide faculty and administrations with the opportunity to re-direct their efforts towards the areas that need the most attention. The DEA could be also useful during the planning phase for programmes or new academic units. Since, programme instructions in Ukraine are often carried out with only limited knowledge of the efficiency of various inputs and outputs, using the DEA before introducing a programme can provide academic managers a good overview about competitors.

8 Literature

Ahn, T., A. Charnes and W. W. Cooper (1988), “Some Statistical and DEA Evaluations of Relative Efficiencies of Public and Private Institutions of Higher Learning”, Socio-Economic Planning Sciences, 22, 259-269.

Andersen P, Petersen N. (1993). A procedure for ranking efficient units in Data Envelopment Analysis. Management Science 39(10): 1261-64.

Athanassopoulos, A. and Shale, E. (1997). ‘Assessing the comparative efficiency of higher education institutions in the UK by means of data envelopment analysis’, Education Economics 5, 117–134.

Australian Vice-Chancellors’ Committee (2004): Information about Australian Universities. http://www.avcc.edu.au/index.asp .

Carrington, R., Coelli, T., Rao, P. (2004): Measuring the performance of Australian Universities: Conceptual Issues and Initial Results. Paper presented on the Asia-Pacific Productivity Conference 2004, University of Queensland, Brisbane, 14-16 July 2004.

Charnes, A., Cooper, W., Lewin, A.; Seiford, L. (1994): Data Envelopment Analysis. Theory, Methodology and Applications, Kluwer Academic Publishers, Boston/ Dordrecht/ London.

Coelli T. Assessing the performance of Australian universities using data envelopment analysis. Centre for efficiency and productivity analysis, University of New England, NSW, 1996.

Coelli, T., D. S. P. Rao, and G. E. Battese (1998), An Introduction to Efficiency and Productivity Analysis, Kluwer Academic Publishers, Boston.

Cohen, E., S. L. W. Rhine and M. C. Santos (1989), Institutions of Higher Education as Multi-Product Firms: Economies of Scale and Scope, Review of Economics and Statistics, 79, 284-290.

Colbert, Levary and Shaner (2000): Determining the relative efficiency of MBA programs using DEA, European Journal of Operational Research 125 (2000) 656-669

Cramon-Taubadel, S. von; Zorya, S. and L. Striewe (eds.) (2001): Policies and Agricultural Development in Ukraine. Shaker-Verlag, Aachen 2001.

Csaki, C. (1999): Agricultural higher education in transforming Central and Eastern Europe. Agricultural Economics 21 (1999) 109-120.

Csaki, C., Feder G., and Lerman Z. (2002): Land Policies and Evolving Farm Structures in Transition Countries, Working Paper No.: 2794, March 5, 2002, World Bank, Washington D.C.

Farrell, M (1957):'The measurement of productive efficiency' Journal of the Royal Statistical Society, Series A, 120(2) pp253-281.

Finnikov, T.: System of the Higher Education, Education Policy and Peer Education Project. UNDP., Kiev.

Johnes, G., Johnes, J. (1993: 'Measuring the research performance of UK economics departments: an application of data envelopment analysis' Oxford Economic Papers, 45 pp332-347.

Johnes J., Johnes G. (1995): 'Research funding and performance in UK university departments of economics', Economics of Education Review, vol 14(3), pp 301-314

Johnes, J. (1996) 'Performance assessment in higher education in Britain' European Journal of Operational Research, 89 pp18-33.

Johnes, J. (2003) Measuring Teaching Efficiency in Higher Education: an Application of Data Envelopment Analysis to Graduates from UK Universities 1993. Lancaster University Management School, Working Paper 2003/007.

Kumbhakar, S. and C. A. Knox Lovell (2003) Stochastic Frontier Analysis. Cambridge University Press. Cambridge.

Lissitsa, A. (2002): Der Transformationsprozess in der Landwirtschaft der Ukraine - eine Analyse der Effizienz und Produktivität von Großbetrieben , Shaker Verlag, 2002, 194 S.

Lissitsa, A. Odening, M. (2005): Efficiency and total factor productivity in Ukrainian agriculture in transition, in *Agricultural Economics* 32, pp. 311–325

Lovell, K. (2004): Looking Back: Advances During the Past "Baker's Decade", Paper presented on the Asia-Pacific-Productivity Conference 2004, Hosted by the Centre for Efficiency and Productivity Analysis, School of Economics, University of Queensland, Brisbane, Australia July 14-16, 2004.

Lovell, K., Rouse, P. (2003), Equivalent Standard DEA Models to Provide Super-Efficiency Scores, Journal of the Operational Research Society, 54, 101-1.

Lovell C.A.K., Walters L.C., Wood L.L. (1994). Stratified models of education production using modified DEA and regression analysis. Chapter 17 in Charnes A, Cooper WW, Lewin AY, Seiford LM (eds), Data Envelopment Analysis: Theory, Methodology and Applications. Boston: Kluwer Academic Publishers.

McMillan, M. L. and D. Datta (1998), "The Relative Efficiencies of Canadian Universities: A DEA Perspective", Canadian Public Policy, 24, 485-511.Rousseau J, Semple J (1995). Two-Person Ratio Efficiency Games. Management Science **41**(3): 435-41.

Ministry of Agricultural Policy of Ukraine 2002: Agricultural Education in Ukraine. (In Ukrainian Language) http://minagro.kiev.ua/AgroOsvita/index.php3 .

Ministry of Education of Ukraine (2002): Statistics about higher education in Ukraine. http://www.mon.gov.ua/education/higher/stat .

Nikitin V. (2001) Equal access to qualitative education. Education Policy and Peer Education Project. UNDP., Kiev.

Redina, T.: Current agricultural economics education in Ukraine – move forward or conservative stronghold? Kiev. Mimeo. Institute of Economic Research, Kiev.

Rothschild, M. and White L. J. (1995), The Analytics of the Pricing of Higher Education and Other Services in Which the Customers Are Inputs, The Journal of Political Economy, Volume 103, pp. 573-586.

Sarafoglou, N. and Haynes, E. K. (1996): University productivity in Sweden: a demonstration and explanatory analysis for economics and business programs, The Annals of Regional Science, Springer Berlin Heidelberg, vol. 30(3), pages 285-304.

Siegel, S., and N. J. Castellan (1988). Nonparametric statistics for the behavioural sciences. New York: McGraw-Hill, Inc.

Simar, L. and Wilson, P. (2003). "Estimation and inference in two-stage, semi-parametric models of production processes" Technical report 0310 IAP statistics network (http://www.stat.ucl.ac.be/Iapdp/tr2003/TR0310.ps).

Sinuany-Stern, Z., Mehrez, A., Barboy, A. (1994): Academic departments efficiency via DEA. Computers and Operations Research 21, 543-556.

State Statistics Committee of Ukraine (2002): Agriculture. Statistical Yearbook. Kiev.

Taylor, B. and Harris, G. (2002). 'The efficiency of South African universities: A study based on the analytical review technique', South African Journal of Higher Education 16, 183–192.

World Bank, 1994. Europe and Central Asia Country Department III: Russian Federation-Agricultural Research, Higher Education and Extension: Subsectoral Analysis and Project Identification.