PRODUCTIVITY AND EFFICIENCY CHANGE IN UKRAINE'S SUNFLOWER SEEDS INDUSTRY: 1998-2002

by

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Abstract

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Abstract

The paper measures productivity and technical efficiency of Ukraine's Sunflower Seeds Industry over the period 1998-2002. The efficiency scores are measured on the level of particular sunflower producers (to identify the sources of inefficiency), than aggregated to region level, and consequently to the industry level.

Two different methodologies (Data Envelopment Analysis and Stochastic Frontier Analysis) are used for the purpose of robustness of conclusions. In the DEA framework analysis one makes use of methodology for obtaining aggregate efficiencies scores of distinct groups with weights derived from economic principles. The statistical inference for the aggregate scores and difference between them over groups is done using statistical bootstrap approach, following Simar and Zelenyuk (2003).

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Chapter 1

INTRODUCTION

The paper measures productivity and technical efficiency of Ukraine's Sunflower Seeds Industry over the period 1998-2002. The efficiency scores are measured on the level of particular sunflower producers (to identify the sources of inefficiency) and than aggregated to industry level. Two different methodologies (Data Envelopment Analysis and Stochastic Frontier Analysis) are used for the purpose of accurate conclusions.

The study is distinctive in several respects. First, sunflower growing became one of the most profitable industries in Ukraine's agriculture. Sunflower seeds have been one of the most profitable crops in agriculture. For example, sunflower seed profitability constituted 77.9 % in 2002 while grain profitability constituted only 19.3% the same year (State Committee of Statistics of Ukraine, 2002). In 2002/03 MY sunflower seeds total output constituted 17% of the world total output. The export of Ukrainian sunflower seeds was 14.8% of the total world sunflower seeds export in 2002\03 MY. Since sunflower seeds is the only crop in steady demand on the world market (TACIS, 1999), its prices are relatively stable, hence exporting sunflower seeds is a stable source of profits for our country. From other side, the share of sunflower seeds in Ukraine's agricultural production export grew up to 14% in 1998 (it was 8% in 2003), whereas the rate of resources utilization dropped from 80% in 1990 down to 34% in 1998 (TACIS, 1999). Also export of sunflower oil constituted 20% of agriculture export in 2003. A not less important fact is that Ukraine exports its sunflower seeds mostly to the EU countries, and export\production ratio was about 40% in 1998 (TACIS, 1999). Taking the importance of the sunflower industry for Ukraine into consideration and fact that Ukraine's priority is to join WTO and EU, it is very important to estimate the actual efficiency and productivity of the industry and its potential capacity.

Second, by this time there was no such a study particularly for the sunflower seeds industry. All previous studies covered only the early period of Ukraine's independence (Johnson et al., 1994), the whole agriculture (Galushko et al., 2003), or only the grain industry for some regions of Ukraine (Kurlakova and Jensen, 1998). Also most studies used only Stochastic Frontier Analysis for farm level data to estimate technical efficiency of production (Johnson et al., 1994, Kurlakova and Jensen, 1998) or only Data Envelopment Analysis (Galushko et al., 2003). So now, paper is going to cover more recent period, specifically 1998-2002. And from methodology side, it would be useful to apply Data Envelopment Analysis in line with Stochastic Frontier Analysis. Specifically, it is applied methodology proposed for obtaining aggregate efficiencies of distinct sub-group (e. g., private and public) and making statistical inference for them, i.e. statistical bootstrap approach to build an appropriate confidence interval for aggregate efficiencies estimates (Simar and Zelenyuk, 2003).

The paper is organized as follows. Chapter 2 discusses relevant literature concerning productivity and efficiency estimations in Ukrainian agriculture and also it touches some problems in estimation efficiency scores in general. Chapter 3 reviews main aspects of sunflower seed industry, i.e. export, production, markets makers. Chapter 4 focuses on methodology features used. Chapter 5 presents description of data used in paper. Chapter 6 shows empirical results. Chapter 7 outlines conclusions and policy implications.

Chapter 2

LITERATURE REVIEW

Although the productivity and efficiency measurement issues have been widely applied in developed countries and it is hard to find field that efficiency analysis would not touch upon, Ukraine only starts doing research on determinants of productivity and efficiency in agricultural sector. By this time there were some attempts to measure productivity and efficiency scores in agriculture, but most of them left questions to be answered.

A bulk of studies covers the last years of USSR period and early period of Ukraine's independence. Johnson at al., (1994) covers 1986-1992 period, Kurlakova and Jensen (2002) cover shorter period, 1989-1992. Murova at al (2002) uses 1991 – 1996 period. The most recent study was conducted by Galushko at al., (2003). She covers 1995 – 2000 period for measuring productivity and efficiency changes in Ukrainian agriculture, and conducts separate estimation of technical, allocative and economic efficiencies for 2001 year. In contrast, current paper gives more/the most recent estimates using data for 1998-2002 years.

A majority of papers tries to observe the whole agriculture sector, neglecting specifics of particular crop in prescribing/recommending some policy tools. In particular, Johnson at al., (1994) measures production efficiency for potatoes, corn, grains, and sugar beets. Murova at al. (2002) examines technical efficiency patterns in Ukraine's crop sector. Galushko at al., (2003) investigates the whole agriculture. Only Kurlakova and Jensen (2002) examine technical efficiency of grain production in Ukraine. Thus, this study extremely focuses on sunflower seed industry, allowing one to find out industry intrinsic features.

It is very interesting how authors try to tackle with issue of heterogeneity in inputs. Only Johnson at al., (1994) uses all available data by dividing territory of country on several zones: steppe (with average precipitation between 350 – 450 mm), forest (with average precipitation between 600 – 700 mm) and mixed. Such a division takes into consideration particular climatic condition inevitably influencing productivity and efficiency. Galushko at al. (2003) makes strong assumption about homogeneity of inputs that is not quite appropriate. Take, for example, the same in all respects farms, except land fertility. Most likely that farm with more fertile land will have higher productivity scores, say 100%, but other only 80%. When aggregating to group productivity, simple mean gives 90%. But if we account somehow heterogeneity, we can get 100% productivity score. The study of Kurlakova and Jensen (2002) covers only Kyivs'ka oblast and Cherkas'ka oblast that, of course, is not representative. This study attempts to estimate efficiency scores within each region of Ukraine, allowing to catch not just agro-climatic features of region but, possibly, some other factors, e.g. administrative ones.

Next note concerns data used and how researches transform (aggregate) individual efficiency scores into group efficiency scores. Although all studies, Galushko at al. (2003), Kurlakova and Jensen (2002), Johnson at al. (1994) used farm-level data, except Murova at al. (2002) which uses oblast data, have final scores in simple average scores, no matter whether they used SFA (Kurlakova and Jensen (2002), Johnson at al. (1994), Murova at al. (2002), or Data Envelopment Analysis (Galushko at al. (2003), Murova at al. (2002)). When we talk about interpretations of parameters in SFA, we say "on average" the change of one factor influences somehow another. So we get simple average estimates in this case. A similar problem occurs when one uses DEA methods. Simple average scores neglect weight of particular farm in group, ignoring economic importance of each firm in industry. That may lead to misleading conclusions about group or subgroup score (Simar and Zelenyuk, 2003). So, we can doubt the precision of result obtained in studies described. In contrast, this paper exploits weighted average technique to get region and consequently industry aggregated efficiency scores, proposed by Simar and Zelenyuk (2003).

Another issue is that each paper exploits different methodologies. Kurlakova and Jensen (2002), Johnson at al. (1994), use SFA; Galushko at al. (2003) uses DEA;

Murova at al. (2002) exploit both. Interesting in that sense is a paper of Piesse, Colin at al., (1995). Comparing the productive efficiency of four cooperative and twelve private dairy farms in the Slovenia over the period 1974 – 1990 they used econometric and programming techniques. Two approaches gave consistent results and complement each other to large extent. The programming approach attributes far higher efficiency scores than econometric one. The reason for this is following. Econometric estimation of the efficiencies that is based on positive and negative deviations around the regression line compares efficiencies within group but fails to effectively compare between groups. In contrast, programming approach compares large farms with small ones thus making possible comparison between group's efficiency scores. Also programming approach is net of scale effect and should correspond to variable return to scale econometric model version. Parametric estimation incorporates test statistics that check the quality of the data, but gives only crude means of defining returns to scale and technical change. The non-parametric approach, on the contrary, suffers from the lack of statistical tests and is sensitive to aggregation of input, e. g. aggregation bias (Fare and Zelenyuk, 2002). Murova at al., (2002) using both methodologies also compare them. Pursuing their objectives, authors discovered the average SFA score being 0.694 in 1991 up to 0.742 in 1996. DEA scores are bit higher and fluctuate from year to year, but display the upward trend over 1991 – 94 and then declined in 1996. So, there is a need for the usage of both (DEA, SFA) methods to get statistically valid inferences.

Further, the authors set, apparently, different tools in explanatory targets of paper. Kurlakova and Jensen (2002) examining technical efficiency of grain production, relationship between technical efficiency and selected manager and farm characteristics; the relative impact of the efficiency changes over the overall decline in Ukrainian grain production over 1989-1992 use simply technical efficiency. Johnson at al. (1994) to give some insights on early reforms in Ukraine also uses simply technical efficiency. Murova at al. (2002) pursue the following objectives. The first objective is to highlight some of the economic policies in Ukrainian agriculture, which have an unclear net effect a priori, and then relate these policies quantitatively by measuring technical efficiency performance on corporate and private farms over the period defined. The second objective is to quantitatively test a particular set of farm level and institutional variables in Ukraine's neighbor, Russia. And they tried to achieve objectives set measuring only technical efficiency. But it looks quite narrow task. What measures technical efficiency is simply how far particular production unit operates from best practice frontier. Of course, it is not enough fully evaluate effects of reform being based simply on technical efficiency. Galushko at al. (2003) uses Malmquist Productivity Index or Total Factor Productivity Index (TFP) for measuring change in productivity in two adjacent years. Index decomposition on technical, scale efficiencies and technological change gives more information about sources of inefficiency. These maters a lot for policy makers since each separate element need different policy tools. For example, poor technical efficiency requires market liberalization and extension services to make farmers obtain suitable inputs and qualified advice on how to use them. According to Galushko's paper, half of regions experienced a decline in Total Factor Productivity (TFP) over 1996-2000 (L'viv, for example, lowest score equals 0.695). But overall, TFP increased by 6%. From Malmquist Index decomposition the authors inferred that decline in TFP for half of regions was due to technical efficiency decline, but six western regions experienced technological regress. The interest result is that TFP growth positively relates to farm size, hence setting priorities for large-scale production. Also authors found that collective farms were the least efficient, while private performed the best. Analyzing allocative and economic efficiencies the paper found enterprises used resources in inefficient way (mean allocative efficiency is only 0.36, meanwhile mean economic efficiency is only 0.08). Johnson at al., (1994) indicate decline in technical efficiency over 1986 – 1992. Mean scores for corn production is 85% in 1986 down to 64 in 1991, for grain 64% down to 58%, for sugar beets 87% down to 70%. Kurlakova, Jensen (2002) also show decline in technical efficiency (average is 79% for 1989 and 60% is for 1992). This result is consistent with other studies (Johnson at al., 1994). Murova at al., (2002) shows the average technical efficiency SFA score to be 0.694 in 1991 up to 0.742 in 1996. In contrast, technical efficiency DEA scores are bit higher and fluctuate from to year, but display the upward trend over 1991 – 94 and then declined in 1996. Pursuing the second objective, the second SFA model shows that only the number of employees per farm and the percent of private land in crop production are statistically significant in explaining technical efficiency scores fluctuations.

In addition, none of the authors described above gives statistical inferences on DEA estimates. It is not clear whether numbers provided differ statistically. Without such information one should be very cautious in inferences, because it is not known whether estimates show economic facts or just sampling variation. In contrast, this paper exploits bootstrap procedure, developed by Simar and Wilson (1996), which gives opportunity to estimate confidence interval for individual technical efficiency scores, as well as for aggregated efficiencies.

From reviewing literature concerning measuring productivity and technical efficiency of Ukraine's agriculture we summarize main niches that will be addressed by current paper:

1. None of the previous studies looked specifically at sunflower industry, thus, making implausible to apply conclusions received for entire agriculture for industry in interest

2. Current paper gives the most recent estimates, i.e. up to 2002 year.

3. Using weighted average technique in aggregation gives more economically justified phenomenon.

4. The paper provides statistical interpretations (confidence intervals, standard errors) for DEA estimates that allows to draw inferences from results obtained

5. Study gives inferences based on two competing (alternative) methodologies (DEA, SFA) that give robustness to estimates.

6. Paper sheds light or at least give perception on effectiveness of 2000 Land reform (will be described in the next chapter).

Chapter 3

INDUSTRY OVERVIEW

There are basically two types of sunflower seeds in the world, oil and confectionary. Ukraine specializes mainly in oil sunflower seed. World sunflower seed production has been increasing over the last decade (Table 1). It was on average of 23.5 million tones (Mt) in the mid 1990s up to 26.8 Mt for 1999-2000.

1. Supply of Sunflower Seeds

The sunflower growing has become one of the profit-making agriculture industries in Ukraine. It is one of the world's leaders in sunflower seeds production, accounting for about 10% in 98/99 and 17% in November 2003 of the world sunflower seeds output (Table 1). Sunflower has become dominant in the structure of industrial crops. Its share increased from 48% in 1990 up to 65% in 1997, and reached 70% in 1998. The "history" of the total harvest of sunflower seeds over the period 1998-2002 is given in Table 3. One can see that total harvested area is approximately the same across the period, but yield is higher in 2000 and 2002 years reflecting in greater harvest those years. Collective agricultural enterprises were the main sunflower seed producers in 1998 (TACIS, 1999). They accounted for 91% in the total output. Individual land plots accounted for 5.1% and private farms accounted for 3.9% in total volume. If we consider the distribution of production of sunflower seeds between enterprises of different ownership structures in four largest regions (Table 6), in terms of sunflower seeds production, in 2001-2002 years one can notice that Limited Liability companies dominate in production of sunflower seeds. They produce more than 50% of total sunflower seeds output in each region. Private owned companies take the second place. They include Private Family Farms, Private Enterprises. Agricultural Cooperatives take the third place. And State owned enterprises take the last place. Almost 60% of Ukraine sunflower production is concentrated in five oblasts: Dnipropetrovs'k (15.13%), Zaporizhya (13.78%), Odessa (8.7%), Donets'k (12.17%) and Kharkiv (10.15%). The rate of capacity utilization dropped from 80% in 1990 down to 34% in 1998 (TACIS, 1999). Sunflower seeds market is characterised by relatively stable prices, reflecting in consumers' confidence in market (Figure 1, UNDP, 2004).

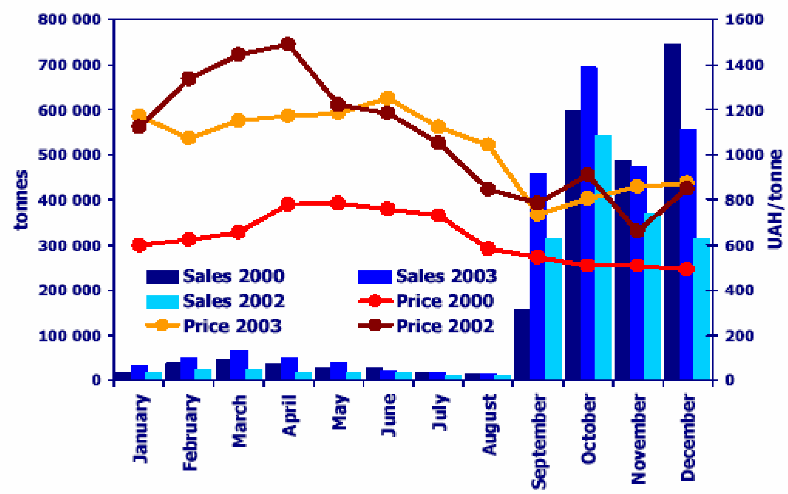

Figure 1. Physical sales and selling prices for sunflower seeds offered by agricultural enterprises in 2000, 2002, and 2003

Source: State Statistics Committee of Ukraine

2. Demand for Sunflower Seeds

Produced sunflower seeds go mostly to sunflower processing plants or to export (Table 2). We can observe that before export duty imposition (23% in 1998) Ukraine was among three largest exporters of sunflower seeds (in June 2001, the tax was lowed to 17%). For example, in 1998/99 MY Ukraine exported less only than Argentina and Russia. But in 2000/01 MY it was the largest exporter, i.e. 43% of the total world export. Export tax had consequences for internal market and for oil-fat industry. In particular, sharp reduction in export, increased domestic supply and hence lower domestic prices. The lower domestic price made oil-fat industry more competitive reflecting in the increase of domestic oil supply hence in oil export growth (400 thousand tons or 15.88 % of total world export) (Shulha, 2003). You can observe dynamics of sunflower seeds and oil on Figure 2 (UNDP, 2004).

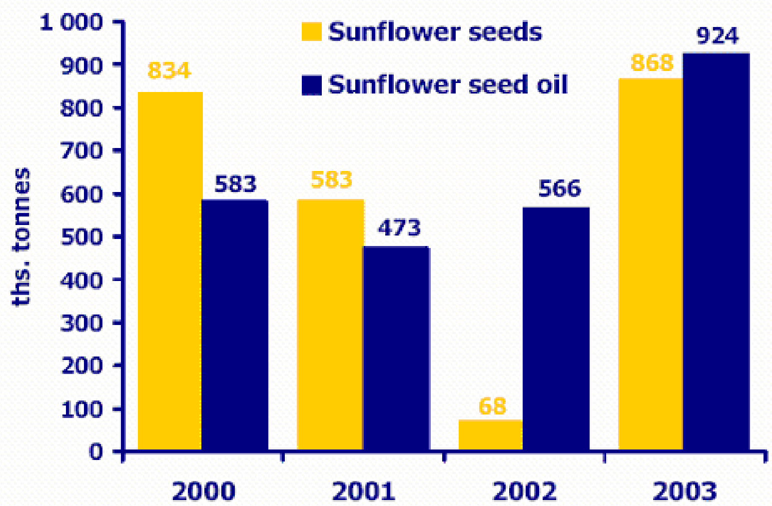

Figure 2. Sunflower seed and sunflower seed oil export dynamics

Source: State Statistics Committee of Ukraine

Over the last five years demand for sunflower seeds is stable due to constant product requirements from oil processors and export side (Table 4). There are 16 sunflower processing plants, united in the *Ukroliyaprom* Association, accounted for 80% of vegetable oil in the country. The rest of the production is done in small-scale processing enterprises with low capacities and outputs. It is worth noting that currently total capacity of Ukrainian oil-fat processors constitute 3.9 mln tons of sunflower seeds, compared to 4.2 mln of 2003 harvest of sunflower seeds (UNDP, 2004).

It is clearly seen from the table that basic mass of sunflower seed is processed by oil-fat processors. More over, considering Sunflower Oil Balances we can conclude that about half of domestically produced sunflower oil is exported abroad (Table 6). The Ukraine's internal vegetable oil requirements are about 450,000 to 500,000 tons. The oil per capita consumption dropped from 11 kilograms down to 8. In the EU countries, for example, per capita oil consumption is 22 – 23 kilograms. Because of the low population incomes and the lack of sufficient current assets in the food industry enterprises, one can hardly expect any substantial increase in the internal demand for sunflower oil so producers should direct on export opportunities.

Sunflower is the only crop in steady demand on the world market (TACIS, 1999). Hence, its prices are rigidly tied up with the US dollar. The share of sunflower seeds in the general structure of Ukraine's agricultural produce export was growing from 5 % in 1992, 7.5% in 1996 up to 14% in 1998, whereas the overall agricultural export volume increased by more than 2.5%. Turkey was the largest importer of Ukrainian sunflower in 1998 (155, 200 tons or 17.1% of total export). 68.2% of the total sunflower export in 1998 went to EU, where main importers were Netherlands (150, 900 t), France (126, 700 t), Spain (108, 800 t), Belgium (81, 200 t), Italy (73, 500 t), Portugal (26, 300), and UK (15, 900 t) (TACIS, 1999).

3. Land Reform 2000

The last most prominent intervention of government was comprehensive land reform, executed in early 2000 (the decree of the President of Ukraine № 1529/99 "About the pressing measures on acceleration of reforming of agrarian sector of economy"). Its essence was that state and collective farms were formally disbanded, and the land of collective farms was distributed among the people of those farms (Aslund , 2002). In reality, a bulk of land was leased back to the old managers of the state and collective farms. Also a good portion of land went to private plots and enterprises, and to the large commercial holdings. Legally agricultural land ownership became highly dispersed, but what are the consequences to that? There were many talks whether this reform was effective or ineffective. This paper simply proposes to see "what data says". After having estimated individual efficiency scores for fife years we can test the reform's effect on this particular firm's performance indicator using kernel estimated density functions.

Chapter 4

METHODOLOGY

This study employs two methodologies, Data Envelopment Analysis (DEA) with extensions and Stochastic Frontier Analysis (SFA).

1. Measurement of Individual Technical Efficiency.

Assume *n* firms operate in industry at question. Each firm *k* ($k=\overline{1,n}$) uses N inputs, $x^k = (x_1^k,...,x_N^k)' \in \Re_+^N$, to produce M outputs, $y^k = (y_1^k,...,y_M^k)' \in \Re_+^M$.

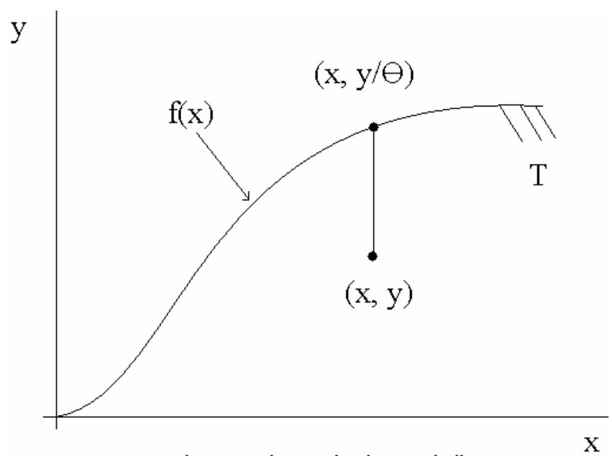

Figure 1. The Production Technilogy

We assume that all *n* firms have access to the same technology T, defined as

$$T^k \equiv \{(x^k, y^k) \;\; : \;\; x^k \textit{ can produce } y^k\},$$

that satisfies standard regularity axioms of production theory (e.g. see Färe, Grosskopf and Lovell (1985). Under these assumptions we can use *output oriented* Shephard (1970) distance function

$$D_o^k : \Re_+^N \times \Re_+^M \rightarrow \Re_+^1 \cup \{\infty\},$$

defined as

$$D_o^k(x^k, y^k) \equiv \inf\{\theta : \; (x^k, y^k / \theta) \in T^k\}$$

, to measure how far each firm k produces from the best practice frontier $f^k(x^k)$ (Fig. 1). $D_o^k(x^k, y^k) \leq 1$, i.e. completely characterizes the technology of the firm *k*. Such an efficiency measure appears in the form of *Farrell* type output oriented technical efficiency, defined as

$$TE^k(x^k, y^k) \equiv \max\{\theta : \; (x^k, \theta\, y^k) \in T^k\} = 1 / D_o^k(x^k, y^k).$$

So, whenever we state that $D_o^k(x^k, y^k) = 1$ or $TE^k(x^k, y^k) = 1$, we assert that firm *k* is *technically* efficient, otherwise is *technically* inefficient.

2. Data Envelopment Analysis

2. 1. Linear Programming Problem

Modern productivity and efficiency analysis is originated by Farrell (1957), and then operationalized and named by Data Envelopment Analysis by Charnes *et* al. (1978). It provides, using linear programming, a means of estimating apparent efficiency scores within a group of producers. The efficiency or inefficiency is estimated relative to the group's observed best practice frontier. It is done by solving the following linear optimization problem for each observation or firm in the sample:

$$TE\ (x^j, y^j) \equiv \max_{\substack{Z_1,\ldots,Z_K \\ \Theta}} \left\{ \Theta :\ \Theta y^j \leq \sum_{k=1}^{K} z_k y_m^k ; x^j \geq \sum_{k=1}^{K} z_k x_n^k ; \sum_{k=1}^{K} z_k = 1; z_k \geq 0; \right.$$
$$\left. k = \overline{1,K}; m = \overline{1,M}; n = \overline{1,N} \right\}$$

z_k are variables that show the intensity with which each firm is used in order to construct the best practice frontier; $y_{k,m}$ is an mth output of kth firm; $x_{k,n}$ is nth input employed by firm k; k is a number of enterprises. DEA operates under some fundamental assumptions. One fundamental assumption in that all firms have access to the same technology, which is denoted as T. Under this assumption we can justify the estimation of one best practice frontier from the entire data. Another fundamental assumption of the DEA is that all observed input-output combinations (x^k, y^k), k = *1,..,n* are feasible under *T*.

2.2. Aggregation.

Let our sample from n firms in an industry be consistent from L sub-groups, say, private and state owned, with n_l firms in each sub-group l ($l=\overline{1,L}$). According to Simar and Zelenyuk (2003), individual efficiency scores are measured as in previous section within their sub-group sample. But aggregate sub-group l efficiency is estimated using weights derived from standard economic reasoning, i.e. output optimization behavior. We want to account for *contribution* of particular firm in total group score. In particular:

$$\overline{TE}^{l} \equiv \sum\nolimits_{k=1}^{n_l} TE^{l,k}(x^{l,k}, y^{l,k}) \cdot S^{l,k},\ S^{l,k} \equiv \frac{py^{l,k}}{p\overline{Y}^{l}},\ \overline{Y}^{l} = \sum\nolimits_{k=1}^{n_l} y^{k}\ .$$

And, by the same manner, aggregate industry efficiency score is defined as

$$\overline{TE} = \sum_{l=1}^{L} \overline{TE}^{l} \cdot S^{l},\ S^{l} = p\overline{Y}^{l} / p\sum\nolimits_{l=1}^{L} \overline{Y}^{l}\ .$$

In other words, when aggregating we weight particular firm efficiency score by its share in sub-group or industry.

2.3 The DEA Estimator.

Since in DEA we fit best practice frontier to the observed data it is seen that $\hat{T} \subseteq T$ (Fig. 2). So, $T\hat{E}(x,y)$ is a downward biased estimator of $TE(x,y)$, i.e., $1 \leq T\hat{E}(x,y) \leq TE(x,y)$, $\forall\ (x,y) \in \hat{T}(x,y)$.

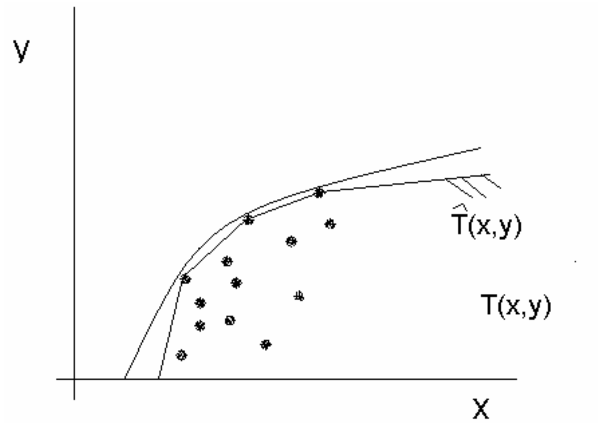

Figure.2. True and Estimated Technology sets

Statistical results for DEA estimator require additional assumptions to recover the data generating process. With these assumptions, Kneip et al., (1998) proved the DEA estimator to be consistent, and

$$T\hat{E}\ (x,y) - TE\ (x,y) = O_P(n^{-2/(M+N+1)})$$

($O_p(\cdot)$, means *at most of order* $n^{(\cdot)}$)

An alternative to this approach is *statistical bootstrap*.

2.4. Statistical Bootstrap.

This section follows mostly Simar and Zelenyuk (2003). The main idea of statistical bootstrap (Efron and Tibshirani, 1993) is that it allows recovering unknown sampling distribution from original data. The main conclusion from the general bootstrap theory is that provided some mild assumptions on the data generating process, bootstrap approximates unknown sampling distribution that is at least as accurate as the approximation given by the first-order asymptotic theory. For the case where the limiting distribution is unknown, as in our example, the bootstrap is the only appropriate alternative. After estimation of individual technical efficiency scores, $T\hat{E}^k$, $k=\overline{1,n}$, and aggregating them, as in 3.2 section, into group efficiency score $\overline{T\hat{E}}$ as an estimator of true group efficiency score $\overline{TE}$, we are interested in the sampling distribution of $\overline{T\hat{E}} - \overline{TE} \mid \wp$, where $\wp$ stands for data generating process for the distribution of our observed data, $\Xi_n = \{(x^k, y^k) \;:\; k = 1, ..., n\}$. The idea of bootstrap is to approximate this distribution by treating Ξ_n as the population, whose properties can be learned by operation with *pseudo-*samples, $\Xi_n^* = \{(x^{*k}, y^{*k}) \;:\; k = 1, ..., n\}$, drawn randomly (with replacement) from this population, Ξ_n. In particular, we apply the procedure presented in previous sections each time we resample from sample. Consequently we get bootstrap estimate, $\overline{T\hat{E}}^*$, of our sample estimate $\overline{T\hat{E}}$. If the bootstrap is *consistent* then we get the following result

$$\overline{T\hat{E}^*} - \overline{T\hat{E}} \mid \wp \quad \overset{asy.}{\sim} \quad \overline{T\hat{E}} - \overline{TE} \mid \wp$$

Kneip, Simar and Wilson (2003a) showed the sub-sampling bootstrap to be consistent for any sub-sample that has a smaller size than the original one. Thus, with this technique we can correct for our downward bias, estimate distribution of estimator and, consequently, infer sampling statistical properties of DEA estimator.

2.5. Outliers Detection Procedure: Jackstrap Technique

This section follows Stosic, B. and Sampaio de Sousa. (2003). Due to the one of the few assumptions imposed on DEA model, i.e. we cannot observe any DMU beyond the frontier, it might sensitive to outliers. Outlier can appear in the sample because of some reasons: i) possible mistyping when filling in account forms; ii) potential outlier can be from another population; iii) misreporting due to impediments of different nature. As a result, it is needed additional technique to detect those possible outliers. "Jackstrap" procedure combines Jackknife and Bootstrap resampling schemes. It is computationally intensive but completely automatic. The algorithm for implementation is follows:

Select randomly a subset of L DMUs (typically 10% of K-original sample size) and perform Jackknife procedure, i.e. apply DEA for each of the selected L DMUs to obtain the set of efficiencies { $T\hat{E}^l, l = 1,..,L,$}. Then one by one remove DMU and each time obtain the set of efficiencies $T\hat{E}^{jl}, l = 1,..,L; l \neq j$, j=1,...,L, index of removed DMUs. Then get the set of leverages for each DMU

$$l_j = \sqrt{\frac{\sum_{k=1;k\neq j}^{L}\left(T\hat{E}^{jl} - T\hat{E}^{l}\right)^2}{L-1}}.$$

Repeat first step B times, thus accumulate the subset leverage information $\tilde{l}_{kb}$ for all randomely selected DMUs (for B large enough, each DMU should be selected roughly $n_k \approx \frac{B*L}{K}$ times).

Calculate mean leverage for each DMU as $\tilde{l}_k = \frac{\sum_{b=1}^{n_k}\tilde{l}_{kb}}{n_k}$, and global mean leverage as $\tilde{l} = \frac{\sum_{k=1}^{K}\tilde{l}_k}{K}$.

Use Heaviside step function to detect outliers: $P\left(\tilde{l}_k\right) = \begin{cases} 1, & \tilde{l}_k < \tilde{l}\log K \\ 0, & \tilde{l}_k \geq \tilde{l}\log K \end{cases}$

2.6. Productivity Measurement.

This paper employs Malmquist Output-Based Productivity Index to provide productivity measurement. It is defined as:

$$M_O(x_t, y_t, x_{t+1}, y_{t+1}) = \left\{\frac{D_O^t(x_{t+1}, y_{t+1})}{D_O^t(x_t, y_t)}\frac{D_O^{t+1}(x_t, y_t)}{D_O^t(x_t, y_t)}\right\}^{1/2}$$

Consequently it can be decomposed in the following components: purely technical efficiency change, scale efficiency change, changes in technology, and shange in scale of technology, as in Simar and Wilson (1998a):

$$\text{TFP} = \Delta\text{PureEff} * \Delta\text{Scale} * \Delta\text{PureTech} * \Delta\text{ScaleTech},$$

where *PureEff* determines 'pure' efficiency change of production unit; *Scale* means change in scale efficiency of production unit; *PureTech* determines only shifts of technology; *ScaleEff* means change in the shape of the technology or changes in the location of the production unit.

2.7.Kernel Estimated Density Function

This paper provides distributions of random variables in terms of Rosenblatt (1956) kernel-based estimate of density function $f(x)$, of a random variable x, based on standard normal kernel function and optimal bandwidth:

$$\hat{f}(x) = \frac{1}{nh}\sum_{j=1}^{n} k\left(\frac{x_j - x}{h}\right),$$

where $\int_{-\infty}^{\infty} f(z)dz = 1$ and $z = \frac{(x_j - x)}{h}$. Here h is the bandwidth, which is a function of sample size n and goes to zero, while n goes to infinity, also it should satisfy $nh \to \infty$. It is estimated using the Sheather and Jones (1991) method.

Based on the integrated-square-error criterion between two group density functions:

$$I(f_{A,} f_B) = \int_x \left(f_A(x) - f_B(x)\right)^2 dx,$$

this paper uses the following statistic to test the equality of two distributions:

$$\hat{\mathrm{T}}_{\mathrm{n_A}, n_B, h} \equiv \frac{\sqrt{2}\mathrm{n_A} h_R^{\ 1/2} \hat{I}_{n_A, n_B}}{\hat{\sigma}_{\lambda, h_R}} \xrightarrow{d} N(0,1) \qquad ,$$

where $\hat{\sigma}_{\lambda,h}$ is a consistent estimator of

$$\sigma_\lambda^2 = 2\left(\int \left(f_A(x) - \lambda f_B(x)\right)^2 dx\right)\left(\int K^2(x) dx\right)$$

(for details see Simar and Zelenyuk (2004)). This is basically Li (1996) test for equality of two densities being adapted by Simar and Zelenyuk (2004) for distribution of efficiency scores estimated via DEA. In this case null hypothesis is:

$$H_O : f_A(x_A) = f_B(x_B);$$
$$H_A : f_A(x_A) \neq f_B(x_B);$$

Next, using sub-sampling homogenous bootstrap one can estimate p-value of the test (probability of incorrectly rejecting the null hypothesis when it is true) as:

$$\hat{p} - value = \frac{1}{B} \sum_{b=1}^{B} I\left\{\hat{T}^b_{s_A, s_B} > \hat{T}_{n_A, n_B}\right\};$$

where I{X} stands for indicator function and B is a number of iterations.

3. Stochastic Frontier Analysis.

SFA methodology uses parametric approach to estimate static technical efficiency. The econometric models can be categorized according to the type of data employed: i. e., cross-sectional or panel. This paper concentrates on cross-sectional data, Battese and Coelli (1992) model specification. Cobb-Douglass form for production function is selected. We estimate our production function $\ln Y_i = \beta_O + \sum_j \beta_j \ln X_{ij} + \varepsilon_i$, using Maximum Likelihood Estimation (MLE). X are inputs (land/labor and gross value of inputs in our case) and Y is output. Error term is defined as $\varepsilon_i = v_i - u_i$. Assumptions imposed on v_i and u_i distributions are:

- $v_i \sim iid \quad N(0, \sigma_v^2)$;
- $u_i \sim iid \quad N^+(0, \sigma_u^2)$;
- v_i and u_i are distributed independently of each other, and of the repressors;

Farm specific technical efficiency scores are obtained using the relationship

$$TE_i = E(\exp\{-u_i \} | \varepsilon_i) = \left[\frac{1 - \Phi(\sigma_* - \mu_{*i} / \sigma_*)}{1 - \Phi(-\mu_{*i} / \sigma_*)} \right] \exp\left\{ -\mu_{*i} + \frac{1}{2} \sigma_*^2 \right\}, \text{ where}$$

$$\mu_* = -\varepsilon\sigma_u^2 / \sigma^2 \quad ; \; \sigma_*^2 = \sigma_u^2\sigma_v^2 / \sigma^2 \quad ; \; \sigma = \left(\sigma_u^2 + \sigma_v^2\right)^{1/2}$$

$\Phi(\cdot)$ is standard normal cumulative distribution function.

C h a p t e r 5

DATA DESCRIPTION

This study employs the data on inputs and output of sunflower seed production for regions of Ukraine over the 1998-2002 period. Table 1 reports statistics for general data. The data at the enterprise level is provided by

Table 1. General Data Description

Year	Variable	Obs	Mean	Std. Dev.	Min	Max
1998	Gross value of inputs (UAH, thd.)	5828	322.4024	268.7463	2	3700
	Sunflower seed output (in centners)		3367.665	3743.58	13	8860
	Arable land (in hectares)		7.659266	7.981012	0	202.1
1999	Gross value of inputs (UAH, thd.)	5960	323.5708	300.92	2	4286
	Sunflower seed output (in centners)		3667.059	4141.24	9	76560
	Arable land (in hectares)		97.44	106.62	1	2250
2000	Gross value of inputs (UAH, thd.)	6078	111.89	129.82	1	3367
	Sunflower seed output (in centners)		278.844	254.92	2	2500
	Arable land (in hectares)		224.75		1	2500
2001	Gross value of inputs (UAH, thd.)	6162	105.95	174.53	0.2	5310
	Sunflower seed output (in centners)		2303.63	3312.24	2	88291
	Labor		8.59	14.05	0.1	552
2002	Gross value of inputs (UAH, thd.)	5926	151.95	237.27	1	6500
	Sunflower seed output (in centners)		3430.25	4795.4	8	106200
	Labor		11.34	17.1	1	376

Derzhkomstrat and contained in the form #50 for agriculture. Data available particularly for sunflower seeds production includes Gross Value of Inputs (UAH, thd), Land (for 1998-2000, ha), Labour (for 2001-2002, man-hour, thd), Output (centners). The summary statistics for region-specific variables are provided in Table 7.a in APPENDIX A. To save space, only regions with more then 5% share of total industry sunflower seeds' production are presented.

Chapter 6

EMPIRICAL RESULTS

Before referring to results it is needed to note ones again that individual efficiency scores are calculated for each region separately, i.e. relative to the particular region best-practice frontier. Therefore it is not allowed to compare individual efficiencies between regions, only within. Also it is not allowed to compare aggregate efficiency scores of the regions, because of the same reason.

From simple exploration of the summary statistics of variables it can be noticed that data is rather dispersed. For example, for the year 1998, the minimum value of Gross value of inputs constitutes 2 000 UAH, whereas maximum value is 3700 thd. UAH; but the mean value is about 323 thd. UAH. So, one should be aware of possible outlier. Consequently, the next sub-section highlights results on the outlier detection test.

1. "Jackstrap" results.

According to the algorithm presented in methodology section, i.e. section 2.5, the leverage scores were calculated for each particular firm within each region. Then, using threshold, determined by Heaviside step function, the outliers were simply eliminated from the sample set. Intuitively the Heavisive step function states that if individual DMU leverage score is, say, 3 times higher (for sample of 1000

DMUs) than global mean leverage for sample, we just drop it. The Kernel estimated densities for efficiency scores on an altered data set, and corrected for outliers set, for the four largest regions of Ukraine, in terms of the level of the sunflower seed production, are presented in Figure 1.

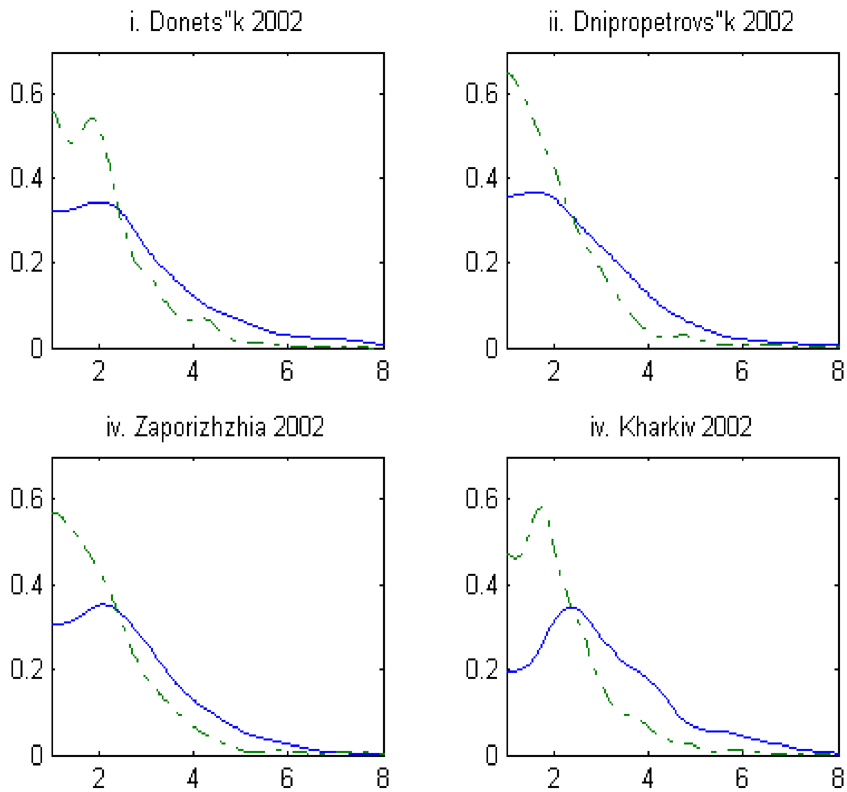

Figure 1. Kernel Estimated Densities for Efficiencies Scores before and after applying Jackstrap procedure. Gaussian kernel is used with the bandwidth selected via Silverman (1986) rule

They are Donets'k, (12.70%), Dnipropetrovs'k (15.13%), Zaporizhya (13.78%), and Kharkiv (10.15%) regions[1]. On graph solid curve stands for Kernel estimated densities on unaltered set and dashed curve stands for Kernel estimated density on corrected set.

It is seen that the removal of the firm with highest leverages score or most influential observation produces, at least visually, significant impact on the efficiency scores. Kernel estimated densities for four regions on unaltered data set were shifted toward the lower efficiency scores region. And after testing for outliers, Kernel estimated densities shifted toward the higher efficiency score region. How those Kernels estimated densities are different? The equality of two kernel estimated density functions for regions under interest is tested as shown in methodology part. Resulting p-value witnesses against hypothesis of equality of two densities at least at 1% significance level (for all four depicted on Figure 1 regions).

2. Region's Individual and Aggregate Efficiency Scores.

After eliminating outliers from the sample we apply techniques described in methodology section, namely statistical bootstrap approach (naïve sub-sampling version of bootstrap) to build an appropriate confidence interval for aggregate efficiencies estimates (Simar and Zelenyuk, 2003). Again, for the purpose of visual perception, chronology of Kernel estimated densities for four largest regions is presented in Figures 2 -5.

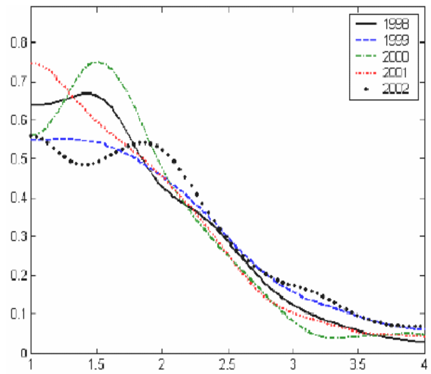

Figure 3. Kernel Estimated Densities for Efficiency Scores. Dnipropetrovs'k 1998-2002

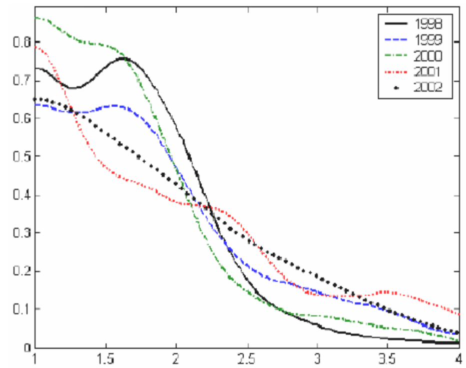

Figure 2. Kernel Estimated Densities for Efficiency Scores. Donets'k 1998-2002

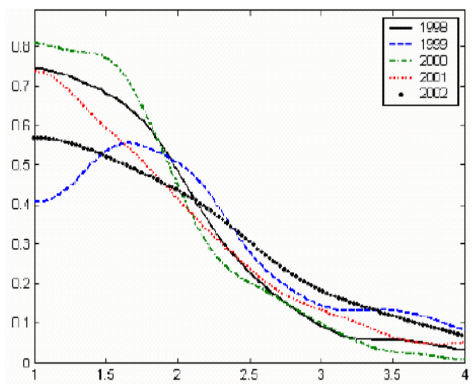

Figure 5. Kernel Estimated Densities for Efficiency Scores. Zaporizhzhia 1998-2002

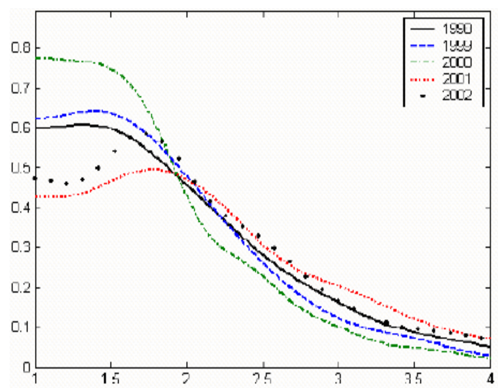

Figure 6. Kernel Estimated Densities for Efficiency Scores. Kharkix 1998-2002

On those figures one can observe how Kernel estimated density distributions changed over the fife year period time for each of four region. Unfortunately, from simple visual inspection it is hard to infer whether Kernel estimated density distributions are different between years for each region. But after applying Li (1996) test adapted for efficiency scores (Simar and Zelenyuk, 2004) we can infer that indeed, kernel estimated densities for regions under interest do not differ significantly. For example, for Dnipropetrovs'k region for 1998-1999 years we cannot reject the hypothesis of distribution's equality at 5% significant level. The same result holds for 1998 and 2000 year, indicating no significant improvements in firms performance that period. But there is a significant difference in distributions in 1998 and 2001 (significance at 1%). Indicating, more likely, worsening (according to the Figure 3) in Technical efficiency scores distribution, because of greater area in the more inefficient part below 2001 density graph then below 1998 density. Result is interesting, in a sense that one could, probably expect opposite result. Since land reform took place in 2000, it is likely to expect some (positive in terms of efficiency of production) change in performance of firms that period. But we only observe opposite to logics result. Next, we do not observe significant difference between 1998 and 2002 years, but density functions are significantly different between 2000 vs. 2001 and 2000 vs. 2002 periods (at 1% significance level). The situation with the rest regions is likely similar to Dnipropetrovs'k region pattern, because densities (at least visually) perform in very similar fashion. Thus, pattern of distributions of individual efficiency scores witnesses against any substantial, one-way improvements in efficiency of sunflower seeds production, and against the effectiveness of 2000 land reform. Of course this implication concerns only efficiency side, nevertheless it conforms to widely stated idea that since most disbanded land was leased back to the old managers this reform had no real influence on industry performance.

Tables 7 present final tables of aggregate estimates (estimates in table are presented in reciprocal to technical efficiency scores, in percentage points). In this table *AgEff* stands for *aggregate efficiency* estimated with simple DEA model. *Effbiascor* stands for *aggregate efficiency scores corrected for bias* (described in the methodology part) resulting from applying naïve sub-sampling bootstrap approach. *Conf_int* stands for 95% confidence interval for obtained estimates, again after applying statistical bootstrap approach.

Tables 7 represent us with estimates, as was mentioned above, that cannot be directly compared between regions. In general, the most "influential" regions in production of sunflower seeds are around 55% efficient (Donets'k and Dnipropetrovs'k regions). All those facts boil down to the overall industry efficiency, i.e. 53% efficiency for 1998, 48% is for 2001, and 51.68% is for 2002 year. Since there are no analogous estimates for any other crop to compare with (for the time period considered in research) we can at least have a rough perception of our results by comparing them with results of similar research that covered later period. For example, Johnson et al., (1994), estimated mean efficiency score for grain, using SFA, to be 0.84. They received this estimate for 1986-1991 periods. Kurlakova and Jensen (2002) estimated mean efficiency score for grain to be 0.71 for the same time period, although they used different model. Galushko (2003) reports bulk of enterprises to be 0.5-0.75 efficient. Besides she used more recent data, DEA approach, but theses estimates are for the whole agriculture. Thus, our estimates are lower then scores described above.

It could be justified due to methodology used and by concentration on particular crop, i.e. only sunflower seeds production.

Thus, discussed above aggregate and individual efficiency scores shows relatively unsatisfactory overall sunflower seeds industry performance (about 50% efficient) and individual firm performance (over the period under interest). Also received efficiency scores and pattern of their distribution in and between years witnesses of impotency of our authority to ensure effective development of agriculture and sunflower industry in particular.

3. SFA versus DEA estimates.

Table 8 presents mean efficiency scores estimated using two methodologies, namely SFA and DEA. Mean efficiency scores are presented for two of the largest regions in terms of sunflower seeds production, i.e. Dnipropetrovs'k (15.13%) and Donets'k (12.17%) regions. It clearly seen that SFA scores are higher then DEA scores. That is not consistent with results received by Murova at al, (2002), which received higher DEA scores then SFA scores. There are, basically, several reasons for that. First of all, this paper exploits simple SFA type model that have different from DEA model assumptions. SFA model is more "imprisoned" in assumptions than DEA model. The purpose of doing that is just to secure results from being completely misleading. And one can see that results are comparable, at least magnitude and direction of change between two years. But "the driving-horse" methodology of this study is DEA. The second reason could be aggregation. SFA reports simple average efficiency scores; while in DEA we used aggregation weighted with firm's output shares in region and industry that is more economically justified.

4. Possible sources of inefficiencies on the example of four largest regions in terms of sunflower seeds production.

Let us concentrate on operation of agriculture enterprises in Dnipropetrovs'k, Donets'k, Zaporizhzhia, and Kharkiv regions in 2001-2002 time period. These four regions accounted for nearly 52% of total sunflower seeds industry output in 2002. Specifically, we investigate operation of agriculture enterprises of different ownership structures. Namely, Limited Liability Companies (Ltd.), Private agricultural companies (private), Agricultural cooperatives (Coop), and State owned agricultural companies (state). As was mentioned in industry overview chapter, Ltd companies produced the largest amount of sunflower seeds in periods under consideration. Private enterprises took the second place, and state owned farms produced the least amount of output. (Table 6).

4.1 Technical Efficiency of Agricultural Enterprises

Table 9 produces estimates of *Bias Corrected* Aggregate technical efficiencies (*AgEff_Corr*) for enterprises of different ownership structure within each region. Higher scores indicate being less efficient. *Low B.* and *Up B.* stands for low and upper bounds of 95% confidence interval of estimates. One can make the following conclusion from the table that although Ltd companies are the most largest producers of sunflower seeds they appeared to be as (in)efficient as private companies, cooperatives, and state owned ones. Although for Donets'k region (2001) Ltd enterprises performed significantly better then other types of enterprises, but they was not in 2002. On the other hand for Dnipropetrovs'k region (2001) state owned enterprises were significantly better then others, but their aggregate efficiency score in 2002 was significantly better only against Ltd enterprises. But this is, probably, an anomaly than a rule, because for the rest regions state owned enterprises were as efficient as others for the same time period. This leads to the conclusion that on group level different ownership structure enterprises perform similar, showing no advantages of ownership pattern on group production efficiency.

To infer valuable information of individual scores, let us refer to the kernel estimated densities of each type firm for every region. It gives us visual perception of how the true distribution of firm's efficiencies might looks like. Figures 6-7 demonstrate Kernel estimated densities for firm's efficiency scores being predominantly one-modal.

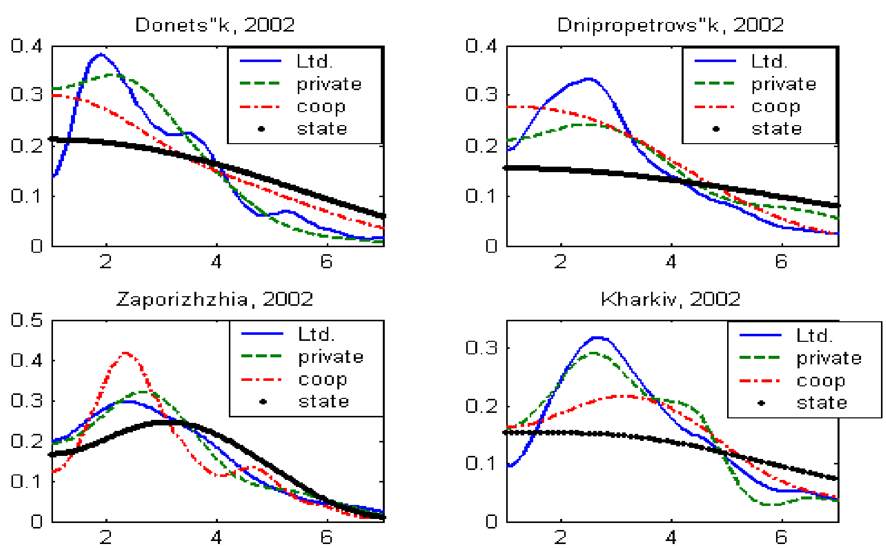

Figure 6. Kernel Estimated Densities from Technical Efficiency Scores for Enterprises of Different Ownership Structure, 2002. Gaussian kernel is used with the bandwidth selected via Silverman (1986) rule.

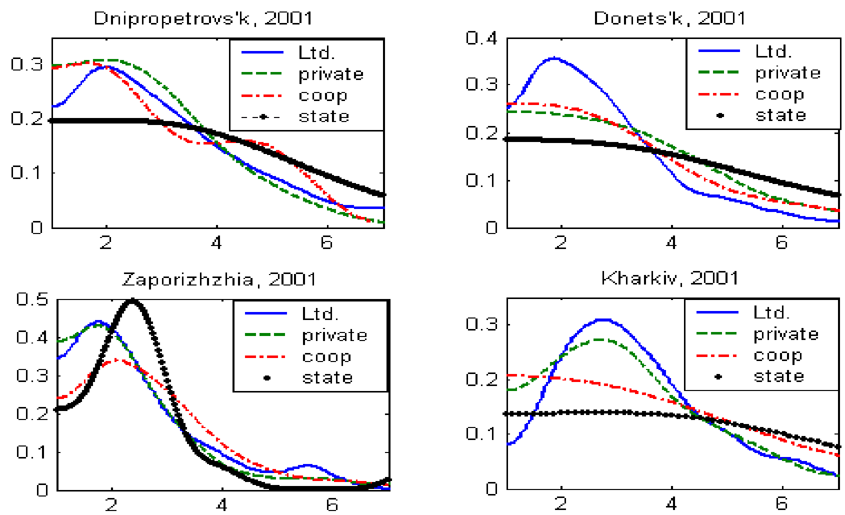

Figure 7. Kernel Estimated Densities from Technical Efficiency Scores for Enterprises of Different Ownership Structure, 2001. Gaussian kernel is used with the bandwidth selected via Silverman (1986) rule.

This indicates that there is no other group of enterprises within considered group. It is hard to say for sure from simple visual inspection whether the distribution efficiency scores of, say, private firms and Ltd companies are different or the same. Again, Li (1996) test adapted for efficiency scores (Simar and Zelenyk, 2004) showed that pattern of kernel estimated distribution between different ownership structure enterprises does not differ significantly for Dnipropetrovs'k and Donets'k regions over 2001-2002.

Thus, group aggregated efficiency scores coupled with individual distribution patterns between each type of ownership structures witnesses for no advantage in any current legal ownership structure in production of sunflower seeds. Also this, probably, points that source of inefficiency is hidden somewhere else.

4.2 Scale Aggregate and Individual Efficiencies of Agricultural Enterprises

Looking at scale efficiency gives us a measure of total level of inefficiency, relative to the constant returns to scale technology (CRS). Intuitively, scale (in)efficiency tells us how far the technology of particular firm or group that it uses from constant return to scale technology. Table 10 and Diagram 2 show that state owned enterprises are the most scale inefficient enterprises for Dnipropetrovs'k region over the 2001-2002 and the most scale efficient for Zaporizhzhia region. But for the whole four regions only cooperatives, in general, perform better, in terms of scale efficiency, than other enterprises. Analysing Kernel estimated distributions of scale efficiencies of enterprises in Dnipropetrovs'k and Donets'k regions over 2001-2002 (Figure 8), it is hard to make inference whether they are different among different types of enterprises (at least just by looking at them).

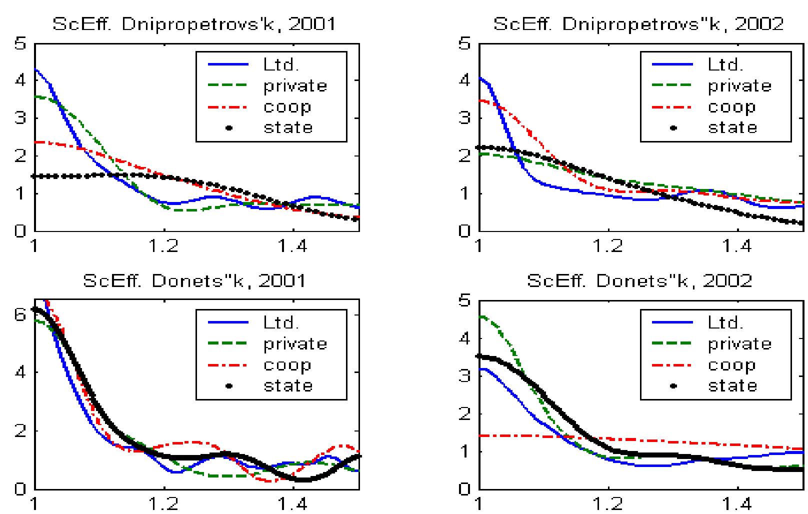

Figure 8. Kernel Estimated Densities from Scale Efficiency Scores for Enterprises of Different Ownership Structure, 2001-2002. Gaussian kernel is used with the bandwidth selected via Silverman (1986) rule.

Nevertheless, some notes could be made. Kernel estimated densities for all type of enterprises are skewed to the efficient part of distribution. But it seems that Cooperatives perform as good as Ltd and Private enterprises, in terms of scale efficiency. It is clearly seen for Donets'k region in 2001 year. State enterprises definitely underperform in Dnipropetrovs'k region that is absolutely unobvious for Donets'k region. According to Kernel estimated densities they perform as good as others do. And, probably, it clarifies why state enterprises in Donets'k region have higher mean scale efficiency scores than Ltd and Private companies have. It could happen due to one or several large farms that appeared to be highly scale efficient.

4.3 Total Factor Productivity and Its Components.

This section presents estimates for Total Factor Productivity change for the four largest regions in terms of sunflower seeds output. TFP is decomposed on four terms and estimated according technique described in methodology section. Table 11 presents estimates of Total Factor Productivity change (TFP) decomposed into Pure Efficiency change (PureEff), Scale Efficiency change (Scale), Pure Technology change (PureTech), and Change in the Scale of the Technology (ScaleTech). Also table 12 shows significance of estimates. If estimates are denoted with asterisk it means that 95% confidence interval of estimates does not cover one. So, it tells whether there was significant change in estimates. Let us first consider cumulative productivity changes for entire pool of enterprises per region and then turn to the examination of how each type of enterprise performs within each region.

Table 11 gives a perception of dynamics of TFP and its components for Dnipropetrovs’k (and other three regions) region. One can notice that TFP of sunflower seed production for region deteriorated in 98/99 by about 3%. This change is attributed to the deterioration of pure efficiency change (about 4.5%);

firms, on average, became closer to CRS technology by 3% (Scale term); region's technology of production enhanced by almost 4%, but it got further from CRS technology by almost 5%. The situation improved a bit over the rest periods. In particular, TFP increased in each period followed 98/99 years. This persistent growth is partly attributed to upward shift of region's technology in those years (26% and 16% respectively), but it showed a time-to-time changeability in scale of technology. Also it is partly attributed to region's improvement in efficiency of production (pure efficiency change) and decrease in using scale of operation (scale efficiency change). It is clearly seen the implication of that figures for the Dnipropetrovs'k region. Firms in region persistently increase efficiency of sunflower production; improve technology of its production. This, probably, attributes mostly to market liberalization processes, and profit maximization incentives of farms. But Scale and ScaleTech terms in the Table should make policymakers to think about it a lot. Deterioration of scale efficiency together with low efficiency scores (we considered it above) indicates that land issue is of primarily impotence for that region, namely how to achieve optimal economy of scale exploitation given restricted land funds. Also technology change component, i.e. change (decrease) in the scale of technology (ScaleTech), requires additional spending on research to achieve new-quality technology. It includes agricultural research, development of machine building for agriculture, and, partly, extension services development. But, of course, it is extension services are "responsible" for pure efficiency performance of firms.

Surprisingly, or may be not, performance of Donets'k region is similar to Dnipropetrovs'k region (in terms of TFP and its components dynamics). Zaporizhzhia and Kharkiv region perform a bit differently but conclusions drawn for Dnipropetrovs'k region stays valid for those regions as well.

Next, let us go deeper in details and consider TFP and its components for each type of firms within each region for 2001/2002 time-period (Table 12). Dnipropetrovs'k region comes first. Here scores under interest for each type of enterprise are in line with total region's score, except for state owned enterprises. Their estimates for pure efficiency change (PureEff), changes in the scale of technology (ScaleTech), and consequently in TFP are in stark contrast to the rest enterprises and overall region scores. It is seen from the table that state owned enterprises do have different scores mentioned above, i.e. TFP, PureEff, and ScaleTech. They have about 40% growth in pure efficiency, but about 13% reduction in scale of technology, and, consequently, it resulted in 47% increase in TFP. But it is more likely a lucky draw for the state owned enterprises (that should, of course, be more elaborated) than a norm, since state enterprises perform as good as other enterprises. As one might have expected (after exploring efficiency scores before) private and Ltd companies performed as better as others (in terms of productivity change). In general (for all four regions) all groups of enterprises experienced only significant deterioration in Scale of technology, significant upward shift of technology, and, as result, significant improvement of TFP. Other estimates experienced insignificant changes. So, in current market or even political conditions, on average, ownership structure does not play a significant role in improvements of productivity and efficiency of sunflower seeds production. Although enterprises experienced positive change in technology, the quality of that technology (how it is curved or close to CRS technology) has been significantly worsened. This particular fact requires urge need for modernization of production and extension services development that could allow producer learn of new kind of technology process.

Chapter 7

CONCLUSIONS

This paper fills in a gap in the field in the sense that it exercises productivity and efficiency analysis specifically for sunflower seeds industry of Ukraine that was not done before. Also it sheds a light a bit on the effectiveness of 2000 Land reform. Study mostly exploits Data Envelopment Analysis supported by Stochastic Frontier Analysis. Statistical bootstrap and weighted aggregation technique are used within the DEA framework for the purpose of robustness of estimates.

Before considering major inferences of study, it should be noted that the first estimation on the data set (like this study exploits) should test for outliers' presence. It is extremely important for DEA approach since it might be sensitive to outliers. This study discovered strong presence of outliers in the sample that completely spoils results of estimations. Jackstrap outlier detection algorithm is simple and successive one in achieving that goal.

So far, DEA analysis approach in line with Naïve sub-sampling and Smooth Bootstrap showed sunflower industry being relatively inefficient industry, which overall industry efficiency scores varied around 50% over the period of 1998-2002 years. Li (1996) test adapted for efficiency scores (Simar and Zelenyuk, 2004) showed that kernel estimated distribution of efficiency pattern has not significantly changed over the period over consideration for each region. This fact, together with aggregate efficiency scores dynamics intuitively witnesses against effectiveness of 2000 Land reform. SFA results, although a bit higher, support qualitatively DEA aggregate results, at least the magnitude of change and dynamics of estimates are similar for both types of model.

In order to identify sources of (in)efficiency we explored each region more rigorously. We selected four the most important regions in terms of sunflower seeds production volumes. Namely, they are Dnipropetrovs'k, Donets'k, Zaporizhzhia, and Kharkiv regions. More over, four types/groups of enterprises were considered within each region. They were selected according to the current legitimate ownership structures, i.e. Limited Liability Companies (Ltd), Private Companies, Cooperatives, and State Owned enterprises. Ltd companies are proved to be the largest producers of sunflower seeds followed by private companies. Analysis of individual and aggregate technical, scale efficiencies and kernel estimated distributions of individual efficiencies proved, in general, ownership structure of enterprises to be insignificant in determining sources of inefficiency, at least for sunflower seeds industry. Each group of enterprises performed relatively similar except state owned enterprises that were significantly the least efficient enterprises only for Dnipropetrovs'k region (according to aggregate efficiency scores). Also mean scale efficiencies and distribution of individual scores seems also indicate the similarity of four types of enterprises for each region.

Total Factor Productivity and its decomposed terms shed additional light on the situation at hand. They only confirmed our information of pattern similarity between groups of enterprises with region and between regions. Almost all types of firms and regions showed improvement significant improvement in TFP. It is attributed mostly to significant upward shift of technology, and significant deterioration of scale of technology. Thus, using information on TFP and its components, coupled with technical and scale efficiency information, one can infer the following implications. In general firms in regions persistently increase efficiency of sunflower production; improve technology of its production. This, probably, attributes mostly to market liberalization processes, and profit maximization incentives of farms. But Scale and ScaleTech terms in the TFP should make policymakers to think about it a lot. Deterioration of scale efficiency together with low efficiency scores indicates that land issue is of primarily importance for that region, namely how to achieve optimal economy of scale exploitation given restricted land funds. Also technology change component, i.e. change (decrease) in the scale of technology (ScaleTech), requires additional spending on research to achieve new-quality technology. It includes agricultural research, development of machine building for agriculture, and, partly, extension services development. But, of course, it is extension services are "responsible" for pure efficiency of firms that also should worry producers.

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APPENDIX A

TABLES

Table 1. Total World Production of Sunflower seed in 98/99 – 02/03 years (Mln T)

	1998/99	1999/00	2000/01	2001/02	2002/03	2003/04, November
World Production	**27.40**	**26.80**	**23.11**	**21.41**	**23.95**	**26.26**
USA	2.39	1.97	1.61	1.55	1.13	1.19
Argentina	7.18	5.76	2.95	3.84	3.70	3.70
Russia	3.00	4.15	3.91	2.67	3.69	4.40
Ukraine	**2.40**	**2.74**	**3.46**	**2.31**	**3.27**	**4.50**
China	1.47	1.76	1.95	1.75	1.86	1.90

Source: Oil World, 2002; FAS, USDA, 2003, Shulha (2003)

Table 2. Total World Export of Sunflower seed in 98/99 – 02/03 years (Mn T)

	1998/99	1999/00	2000/01	2001/02	2002/03
Total Export	**4.05**	**3.08**	**2.73**	**1.7**	**2.36***
USA	0.29	0.17	0.15	0.17	0.11*
Argentina	0.94	0.27	0.09	0.30	0.44*
Russia	0.9	0.82	0.75	0.03	0.25*
Ukraine	**0.89**	**0.43**	**1.02**	**0.09**	**0.35***

Source: Oil World, 2002; * - predicted, Shulha (2003)

Table 3. Production of Sunflower Seeds: 1998-2002

Indicator	Year				
	1998	1999	2000	2001	2002
Area harvested, thd. ha	2431	2800	2842	2396	2719
Yield, centn/ha	9.3	10	12.2	9.4	12
Total harvest, thd tons	2266	2794	3457	2251	3271

Source: State Statistics Committee of Ukraine, 2003

Table 4. Sunflower Seeds Balances

Indicator	Marketing Year (MY)			
	2000/01		2001/02	
	thd tons	%	thd tons	%
Total Supply	3527	100	2436	100
Production	3457	98	2251	92.4
Import	6	0.2	5	0.2
Total Demand	3347	100	2416	100
Processing for Oil and other food goods	2215	66.2	2136	88.5
Export	1017	30.4	200	8.3

Source: State Statistics Committee of Ukraine, 2003

Table 5. Sunflower Oil Balances

Indicator	Marketing Year (MY) 2000/01		2001/02	
	thd tons	%	thd tons	%
Total Supply	1020	100	917	100
Production	980	96.1	890	97.1
Import	3	0.3	5	0.2
Total Demand	995	100	897	100
Domestic Consumption	480	48.2	527	58.8
Export	510	50.8	360	40.1

Source: State Statistics Committee of Ukraine, 2003

Table 6. Production of Sunflower Seeds by Type of Producer

Regions	Ownership strucrture	2001 # of enterprises	2001 Harvest, thd tons	2001 Share	2002 # of enterprises	2002 Harvest, thd tons	2002 Share
Dnipropetrovs'k	Ltd.	304	1486029	0.76	313	2297272	0.76
	Private	59	328533	0.17	62	470414	0.16
	Cooperatives	23	85069	0.04	22	116310	0.04
	State	14	64549	0.03	15	122070	0.04
Donets'k	Ltd.	372	1465500	0.88	342	2157433	0.89
	Private	39	118080	0.07	37	151119	0.06
	Cooperatives	17	52263	0.03	15	67899	0.03
	State	13	35234	0.02	12	42595	0.02
Zaporizhzia	Ltd.	199	1062500	0.61	238	1710041	0.61
	Private	54	289930	0.17	74	562736	0.20
	Cooperatives	90	346150	0.20	67	440401	0.16
	State	16	47664	0.03	16	77267	0.03
Kharkiv	Ltd.	273	967063	0.58	254	1252669	0.61
	Private	140	500614	0.30	134	602424	0.29
	Cooperatives	44	147181	0.09	36	150061	0.07
	State	20	43513	0.03	20	57784	0.03

Source: State Statistics Committee of Ukraine, 2003

Table 7. Aggregate Efficiency Scores

Regions	1998 AgEff	1998 Effbiascor	1998 Conf_int Up	1998 Conf_int Low	1998 Share	2002 AgEff	2002 Eff_corr	2002 Conf_int Up	2002 Conf_int Low	2002 Share
Crimea	52.6	46.39	52.41	41.99	2.22	47.23	39.43	46.47	35.1	0.47
Vinnyitsa	50.77	45.03	49.62	41.71	1.29	54.23	47.25	52.11	43.7	2.37
Volyn	---	---	---	---	0.00	--	--	--	--	0.00
Dnipropetrovs'k	62.12	56.25	60.47	52.83	14.99	60.19	53.56	58.38	50.0	15.13
Donets'k	61.42	55.22	59.59	51.96	12.04	61.26	54.49	60.61	49.7	12.70
Zhytomyr	---	---	---	---	0.01	--	--	--	--	0.04
Zakkarpattia	---	---	---	---	0.01	89.11	85.23	105.68	80.4	0.02
Zaporizhzhia	62.14	56.46	60.87	52.95	13.62	56.95	50.32	54.99	46.9	13.78
Ivano-Frankivsk	---	---	---	---	0.01	--	--	--	--	0.01
Kyiv	56.20	49.20	56.05	44.63	0.46	49.95	41.70	48.00	37.8	0.51
Kirovohrad	59.26	52.83	56.74	49.47	8.01	60.00	52.78	57.27	49.2	8.85
Luhans'k	---	---	---	---	0.00	57.99	51.55	57.78	46.5	7.26
L'viv	---	---	---	---	0.00	--	--	--	--	0.00
Mikolaiv	58.20	51.13	55.36	47.98	8.45	59.88	52.50	57.35	48.9	6.67
Odesa	58.07	52.38	56.63	49.04	12.73	65.98	60.41	65.13	56.7	8.70
Poltava	58.13	52.00	56.01	48.77	5.80	52.29	44.37	49.07	40.7	6.23
Rivne	---	---	---	---	0.00	--	--	--	--	0.01
Sumy	53.48	46.38	52.23	42.59	1.19	59.36	52.02	57.38	48.2	1.07
Ternopil	---	---	---	---	0.02	70.79	58.39	69.52	54.7	0.02
Kharkiv	57.74	51.18	56.18	47.56	9.97	55.98	48.44	52.99	45.0	10.15
Kherson	61.30	54.97	59.83	51.52	6.19	56.26	48.13	55.63	43.6	2.21
Khmel'nyts'kyi	53.58	45.97	59.35	40.02	0.08	61.61	51.90	65.72	46.2	0.07
Cherkasy	54.73	49.35	53.91	45.77	2.86	57.05	50.67	56.55	45.6	3.38
Chernivtsi	---	---	---	---	0.00	60.55	51.66	61.90	46.0	0.14
Chernihiv	52.76	43.16	53.29	38.13	0.06	60.90	52.68	63.04	47.3	0.20
Ukraine	59.44	53.27	57.75	49.83		58.65	51.68	56.84	47.7	

Table 7a. Data Description by Region

Regions		2001			2002		
	Statistics	**Gross Value of Inputs, UAH thd.**	**Labor, thd. Pers/hour**	**Output, centner**	**Gross Value of Inputs, UAH thd.**	**Labor, thd. Pers/hour**	**Output, centner**
Dnipropetrovsk	Obs	412	412	412	421	421	421
	Mean	217.7	14.248	4889.1	313.95	17.893	7242.4
	Std. Dev.	261.42	16.869	4798.4	356.02	20.608	7209
	Min	6.6	1	101	1	1	54
	Max	2848.8	108	32489	2633	135	50494
Donetsk	Obs	450	450	450	412	412	412
	Mean	180.96	16.004	4003.4	287.24	23.138	6188.1
	Std. Dev.	313.19	22.824	5944.7	592.96	38.301	11085
	Min	1.4	1	28	2	1	52
	Max	5310	250	88291	9314	412	1.63E+05
Zaporizhzhia	Obs	362	362	362	400	400	400
	Mean	216.3	14.227	4856.3	297.96	19.205	7057.1
	Std. Dev.	155.71	14.503	3735.4	226.54	20.139	5895.7
	Min	3.9	1	74	8	1	61
	Max	1033.3	96	21789	1362	195	37413
Kirovohrad	Obs	434	434	434	396	396	396
	Mean	103.44	8.7903	2474.5	184.67	13.869	4633.1
	Std. Dev.	92.638	10.277	2257.8	146.01	13.348	3394.5
	Min	3	1	104	7	1	120
	Max	1027	95	15812	1462	129	22056
Mikolaiv	Obs	405	405	405	375	375	375
	Mean	115.39	10.035	2418.8	166.35	13.797	3761.2
	Std. Dev.	97.796	10.385	2101.5	149.39	14.078	3395.1
	Min	6	1	123	5	1	151
	Max	708	73	12308	1263	84	19594
Odesa	Obs	683	683	683	629	629	629
	Mean	96.682	9.3997	2236.6	132.16	13.921	2858.8
	Std. Dev.	101.51	12.654	2306.3	142.43	17.589	3067.9
	Min	2	1	23	1	1	26
	Max	1126	199	19920	1475	222	28778
Poltava	Obs	514	514	514	490	490	490
	Mean	70.25	4.8774	1545.1	118.22	6.2551	2686.5
	Std. Dev.	62.77	5.7456	1724.2	162.56	9.2196	2985.5
	Min	2	1	10	4	1	60
	Max	618.1	48	19280	2538	98	38924
Kharkiv	Obs	486	486	486	451	451	451
	Mean	146.23	8.5535	3467	198.1	11.313	4647.7
	Std. Dev.	260.51	8.5762	3055.5	333.25	12.982	4404.4
	Min	3.7	1	112	2	1	53
	Max	5006.2	63	27790	6440	159	47361
Kherson	Obs	261	261	261	222	222	222
	Mean	108.94	10.46	1736.8	128.65	11.991	2033.6
	Std. Dev.	96.791	11	1709.7	130.78	14.19	2204.7
	Min	3	1	10	3	1	27
	Max	612	68	8646	823	81	11330

Table 8. Mean SFA and DEA Efficiency scores

Region	Mean Eff SFA	Mean Eff DEA	Mean Eff SFA	Mean Eff DEA
	2002		2001	
Dnipropetrovs'k	0.72	0.52	0.68	0.49
Donets'k	0.75	0.52	0.67	0.53

Table 9. Aggregate Efficiency Scores for each Ownership Structure Enterprise

Region	Mean AgEff DEA, 2001											
	Ltd.			Private.			Coop			State		
	Low B.	AgEff _Corr	Up B.	Low B.	AgEff _Corr	Up B.	Low B.	AgEff _Corr	Up B.	Low B.	AgEff _Corr	Up B.
Dnipropetrovs'k	1.84	1.894	1.950	1.805	1.856	1.923	1.83	1.876	1.92	2.244	2.347	2.48
Donets'k	1.68	1.728	1.772	1.836	1.906	1.976	1.89	1.937	1.97	1.868	1.910	1.96
Zaporizhzhia	1.81	1.8435	1.887	1.783	1.8299	1.881	1.914	1.9505	1.99	2.362	2.407	2.47
Kharkiv	2.01	2.0546	2.113	1.9563	2.0008	2.056	2.079	2.1278	2.19	2.88	2.952	3.05

Region	Mean AgEff DEA, 2002											
	Ltd.			Private.			Coop			State		
	Low B.	AgEff _Corr	Up B.	Low B.	AgEff _Corr	Up B.	Low B.	AgEff _Corr	Up B.	Low B.	AgEff _Corr	Up B.
Dnipropetrovs'k	1.88	1.930	1.984	1.747	1.791	1.842	1.75	1.788	1.82	1.718	1.785	1.86
Donets'k	1.79	1.858	1.928	1.952	2.010	2.081	1.82	1.881	1.95	1.835	1.878	1.93
Zaporizhzhia	1.95	2.0013	2.058	1.895	1.939	1.992	1.858	1.9069	1.96	2.2681	2.3219	2.39
Kharkiv	1.93	1.981	2.044	1.904	1.9503	2.0085	2.148	2.1965	2.26	2.2479	2.3043	2.37

Table 10. Aggregate Scale Efficiency Scores for each Ownership Structure Enterprise

Region	Mean ScEff DEA, 2001				Mean ScEff DEA, 2002			
	Ltd.	Private	Coop	State	Ltd.	Private.	Coop	State
Dnipropetrovs'k	1.5434	1.5016	1.302	1.6996	1.5364	1.475	1.3104	1.8175
Donets'k	1.2638	1.3373	1.1	1.2568	1.3738	1.272	1.1179	1.187
Zaporizhzhia	1.1821	1.1568	1.1353	1.0836	1.1499	1.1731	1.142	1.0306
Kharkiv	1.4494	1.4202	1.2357	1.2183	1.4407	1.1714	1.1355	1.1504

Table 11. Dynamics of Total Factor Productivity and its Components

Regions	Years	PureEff	Scale	PureTech	ScaleTech	TFP
Dnipropetrovs'k	98/99	0.9516*	1.0395	1.041*	0.9461*	0.9745*
	99/00	1.099*	0.9629	1.315*	1.042	1.454*
	00/01					
	01/02	1.0274	1.0146	1.202*	0.9279*	1.167*
Donets'k	98/99	0.9248*	1.026	1.063*	0.9579*	0.968*
	99/00	1.0847*	0.96673	1.257*	1.034	1.365*
	00/01					
	01/02	0.9323*	0.9552	1.256*	0.9388*	1.053*
Zaporizhzhia	98/99	0.8586*	1.0255	1.349*	0.93572*	1.116*
	99/00	1.2127*	0.99407	0.97458	1.0275	1.209*
	00/01					
	01/02	0.9264*	1.022*	1.269*	0.8957*	1.081*
Kharkiv	98/99	1.02	0.98518	1.0577*	0.9973	1.061*
	99/00	1.0821*	0.9541*	1.311*	1.051*	1.4219*
	00/01					
	01/02	1.067*	1.017	1.044*	0.9125*	1.034*

Table 12. Total Factor Productivity and its Components for Each Group of Enterprises

Regions	Years	Ownership strucrture	PureEff	Scale	Pure Tech	Scale Tech	TFP
Dnipropetrovs'k	01/02	Ltd.	0.97844	1.0204	1.2647*	0.89268*	1.13*
		Private	1.0284	1.0556	1.2731*	0.91743*	1.27*
		Coop	1.0465*	0.725*	1.2162*	0.91137*	0.83*
		State	1.311*	0.9928	1.2921*	0.86812*	1.473*
Donets'k	01/02	Ltd.	0.9227*	0.9474	1.2671*	0.93041*	1.035*
		Private	0.94692	0.9904	1.2277*	0.91154*	1.052*
		Coop	1.0252	0.841*	1.2524*	0.96147	1.0437
		State	1.0167	0.9934	1.2373*	0.92442*	1.158*
Zaporizhzia	01/02	Ltd.	0.9162*	1.037	1.269*	0.88457*	1.071*
		Private	0.9402*	1.024	1.281*	0.90009*	1.114*
		Coop	1.0182	0.824*	1.249*	0.89349*	0.933*
		State	1.0332	1.056	1.269*	0.8836*	1.23*
Kharkiv	01/02	Ltd.	1.0387	1.081*	1.118*	0.8318*	1.05*
		Private	1.0292	1.159*	1.086*	0.8433*	1.093*
		Coop	0.97144	0.906*	1.074*	0.8656*	0.823*
		State	1.2824*	1.087*	1.085*	0.8605*	1.304*

APPENDIX B

DIAGRAMS

Diagram 1. Aggregate Technical Efficiency scores

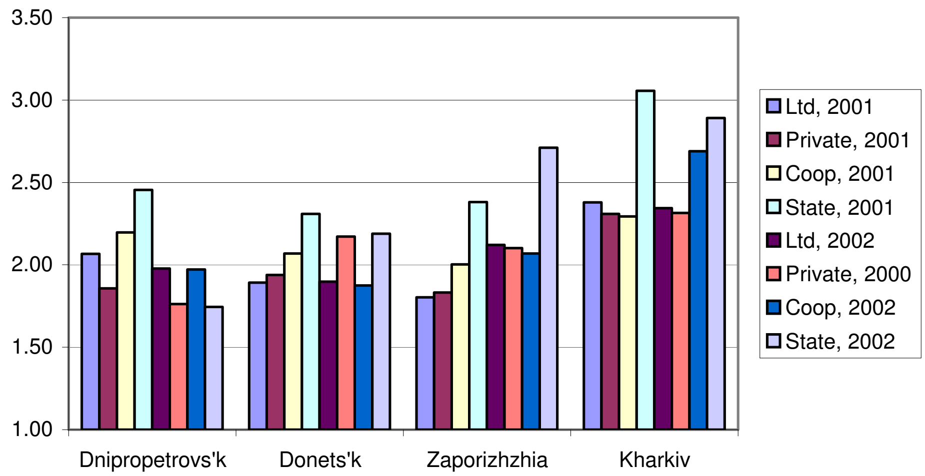

Diagram 2. Mean Scale Efficiency Scores