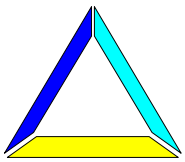
INSTITUTE FOR ECONOMIC RESEARCH AND POLICY CONSULTING IN UKRAINE
GERMAN ADVISORY GROUP ON ECONOMIC REFORM

Reytarska 8/5-A, 01034 Kyiv, Tel. (+38044) 228-6342, 228-6360, Fax 228-6336
E-mail: institute@ier.kiev.ua, http://www.ier.kiev.ua



T4

Efficiency and Productivity Growth in Ukrainian agriculture

Executive Summary and Recommendations

This paper presents the results of new methodology for calculating enterprise efficiency. This methodology is employed in market-oriented economies and is different from the methodology employed in Ukraine that uses as a starting point profitability rate and net profits per hectare of land.

The main findings of the efficiency analysis applied to agricultural enterprises are:

- Total factor productivity growth is positively related to farm size. Even though large agricultural enterprises appear to be less efficient, they appear to experience greater efficiency improvements and to enjoy faster *rates* of technological progress compared to small farms. This finding is valuable for policy-makers because it, on the one hand, testifies that large-scale production is important for diffusing technology through agricultural sector and, on the other hand, calls for facilitating access to service and capital markets by small farms.
- Of the four most important forms of ownership, cooperatives are the least technically efficient on average. This finding suggests that structural change in Ukrainian agriculture will lead to cooperatives being gradually replaced by more efficient forms of ownership such as private enterprises and agricultural companies.
- The average value of technical efficiency in Ukrainian agriculture is rather low. Inefficiency arises due to over-utilization of all resources. Thus, it is important for agricultural producers to learn to economize on resources. Investments into research, training programs for farmers and agricultural education need to be increased in order to ensure that managers and farmers make the best possible use of the existent capital stock and quickly learn to operate modern technologies. Further, average efficiency scores are very low because they are pulled down by a fairly large number of highly inefficient enterprises. These farms should face more pressure to either increase efficiency or exit agriculture. To this end policy-makers should direct their efforts to the elimination of input market imperfections, since competitive markets are the most flexible and efficient mechanism for allocating resources. For example, the existence of a well functioning land market would enable farmers to allocate land to more efficient uses.
- By supporting agricultural producers by, for example with subsidized credits, the government can encourage investments into capital stock and,

consequently, technological progress. However, this will not necessarily result in increased efficiency in an economic sense, because government support will create incentives for managers to put more of their efforts into securing this support rather then improving production efficiency. Furthermore, since technological progress is, to a great extent, a matter of catching-up with modern technologies, the creation of favorable conditions to attract especially foreign investment into agriculture as a means of transferring innovations and know-how is more important than direct government support.

1 Introduction

Transition from a planned to a market economy has proven to be a painstaking process for Ukraine as a whole and for its agricultural sector in particular. Over the last years in Ukrainian agriculture a number of radical reforms have been undertaken. The most important events were (i) land reform intended to reduce the number of state-owned and collectively-owned enterprises and favor the development of private ownership, and (ii) liberalization of agricultural markets. Theoretically, agricultural reform is supposed to manifest itself in increased productivity of resources involved in production, enhanced competitiveness and, as a result, increased efficiency and profitability. However, the observed patterns of development paths in Ukrainian agriculture show that over the first ten years of transition agricultural output and productivity actually declined.

This analysis is important for several reasons. First, at the aggregate level, explaining productivity changes is valuable for policy-makers, since it reveals the potential sources of productivity growth and, possibly, output expansion. Second, efficiency analysis at the farm level allows to find out the determinants of inefficiency and to assess which and how many resources can be freed out of agriculture and allocated to more efficient uses without reducing output. Third, this analysis gives policy makers an idea of how heterogeneous the sector is, which should be allowed for when developing agricultural policies because policies targeted to the average enterprise may turn out to be ineffective and result in a waste of resources. Hence, efficiency analysis provides valuable policy guidelines if a policy-maker is interested in increasing average efficiency in the sector.

This paper reviews these trends in Ukrainian agriculture over a five year period and provides a comprehensive analysis of the changes in productivity, technical efficiency and technological change. We also estimate technical, economic and allocative efficiencies at the level of individual agricultural enterprise and analyze the linkages between an enterprise's efficiency and its ownership pattern. An effort is also made to identify the effect of such factors as farm size, the degree of specialization and fertilization of soil on an enterprise's efficiency.

2 Efficiency of agricultural enterprises in Ukraine: theoretical concepts and some empirical evidence

Economic theory defines three types of efficiency: technical, allocative and economic. T*echnical efficiency* of an enterprise refers to its ability to extract as large an output as possible from a given set of resources. *Allocative efficiency* measures the ability of an enterprise to combine inputs such that the cost of producing of a given level of output is minimized. *Economic efficiency* is the combination of both and can be found

as the product of technical and allocative efficiencies. Efficiency scores run from zero to one, with an enterprise having a score of one being fully efficient. Technical efficiency scores show how much inputs use can be reduced without reducing output. For example, a score of 0.85 shows that the amounts of all inputs used in production could be reduced by 15% ([1-0.85]*100%) without reducing output. The most efficient enterprises serve for constructing reference technology, while the rest of the enterprises are compared with these best ones.

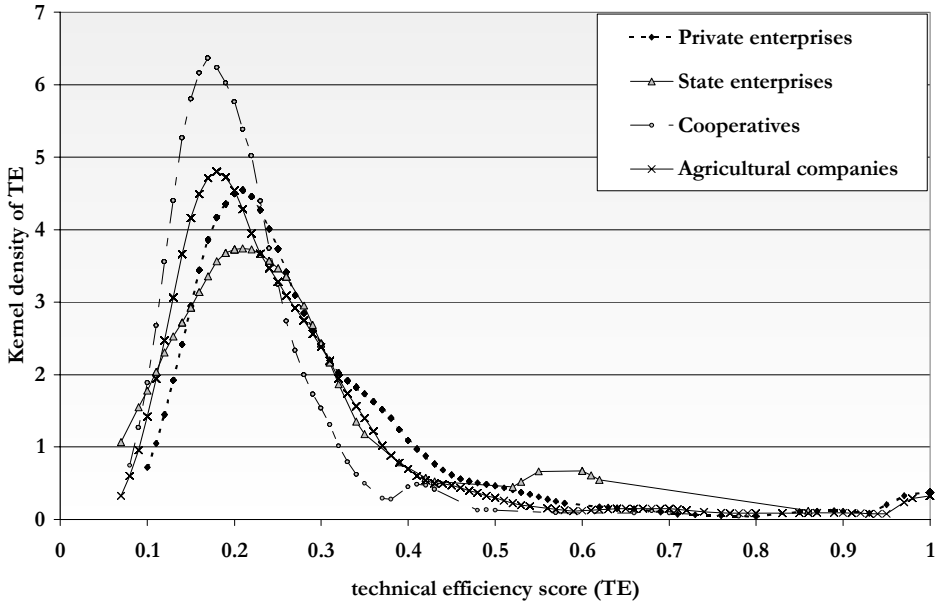
In this paper we measure all three types of efficiency. The data employed were provided by Derzhkomstat and were contained in forms #50 for agriculture. These are financial statements of agricultural enterprises for 2001. As an output we use total sales revenue. A potential problem with using this variable is that it does not tell us about actual production in physical units and may be somewhat misleading especially if enterprises of different forms of ownership face different output prices. For simplicity we assume that prices are identical for all enterprises. 4 inputs are used in the analysis: energy, the value of fixed and circulating assets, land and labor. Energy consumption is measured in kW-hours.

The research covers 84% of the agricultural enterprises that functioned in 2001 in 5 central oblasts– Vinnytsa, Kirovograd, Cherkasy, Kyiv and Poltava. In total the sample includes 2482 observations: agricultural companies (1480), private enterprises (549), state enterprises (67) and cooperatives (386).

We assume that enterprises of all forms of ownership have access to the same technology and thus, we calculate technical efficiency scores for the pooled sample under the assumption of variable returns to scale. The distribution of enterprises according to the magnitude of *technical* efficiency scores is graphed in Figure 1[1].

[1] All technical details of the analysis discussed in this paper are contained in working paper No.20 "Farm Efficiency and Productivity Growth in Ukrainian Agriculture", Institute for Economic Research and Policy Consulting, July 2003.

Figure 1. Distribution of agricultural enterprises according to the value of technical efficiency



As can be seen in Figure 1, the average value of technical efficiency is the lowest for cooperatives at 0.19, which implies that relative to the best enterprises in the sample, resource use by cooperatives is on average higher by 81%. The mean value of technical efficiency is the highest for private enterprises at 0.24. There is only a slight difference in technical efficiency between private enterprises and agricultural companies, and the latter seem to be the most heterogeneous category among the four.

The most efficient enterprises tend to use less of each input to produce one unit of output. Furthermore, cooperatives tend to use more of each of these inputs per unit of output than all other forms of ownership. The picture is, however, vague for fertilizer use. The results also show that there is a positive relation between capital intensity and technical efficiency. We define capital intensity as the capital-labor ratio where capital services (the cost of electricity and fuel consumption and repairs) serve as a proxy for capital. The general trend observed for the agricultural enterprises under study is that an enterprise's efficiency increases with its capital-labor ratio. It is often claimed and seems to be supported in our case that labor-intensive enterprises use more labor *and* more capital per unit of output compared to enterprises with high capital-labor ratios. Thus, labor-intensive farms are less technically efficient than otherwise identical farms employing more capital-intensive techniques.

Since the sample includes only 67 state enterprises, allocative and economic efficiencies cannot be dependably calculated for this group. These measures are calculated for the other three group of farm enterprise and the results are summarized in Table 1 below.

Table 1. Mean values of technical, allocative and economic efficiencies

	Technical efficiency	Allocative efficiency	Economic efficiency	**Net profit per ha**
Private enterprises	0.243	0.378	0.093	**990**
Agricultural companies	0.236	0.371	0.085	**530**
Cooperatives	0.185	0.283	0.051	**550**
Average	***0.23***	***0.36***	***0.08***	***690***

As the calculated efficiency scores reported in Table 1 reveal, allocative and economic efficiencies are rather low. The average value of economic efficiency is very low and equals 0.08, which indicates the poor ability of agricultural enterprises in Ukraine both to extract as much output as possible from a given set of inputs and to choose the right mix of these inputs. This can partly be explained by underdeveloped or absent input markets (for example, land market), which distorts input prices and, as a result, prevents enterprises from allocating resources efficiently.

The calculated efficiency scores often can also be used for comparing efficiency of enterprises of different forms of ownership. It is often claimed that private and owner-managed enterprises are the most efficient because in most cases the manager is the owner and has a strong incentives to keep a close eye on things. In enterprises where there are many owners and management is separated from ownership, managers may have an incentive to satisfy their own objectives rather than use resources in the most efficient way.

In our results, private is found to be the most efficient form of ownership. In other words, the returns on each hryvna invested into production are on average the highest for private enterprises. Cooperative ownership patterns are the least efficient. Agricultural companies and private enterprises are almost equally technically efficient with private enterprises being only slightly more technically efficient. However, if one compares net profits per 1 ha of agricultural land private enterprises appear to perform much better in this respect. An explanation for this finding is that some part of agricultural companies are highly inefficient and suffer large losses per 1 ha of land due to which the *average* value of net profits is pulled down and is less than that for private enterprises. A plausible explanation for agricultural companies and private enterprises being almost equally technically efficient is that in most cases agricultural companies are family-owned (for example, when a husband and a wife are the only shareholders) and there is no real difference between private ownership and partnership except for the formal name. The fact that the number of owners substantially fluctuates within the category of agricultural companies compared to other categories explains why agricultural companies are the most heterogeneous category. We suspect that there is a positive relationship between the number of owners and inefficiency within this category. This issue should be analyzed more deeply if the necessary information is available.

It is also worth mentioning that even though cooperatives are less efficient on average, the best ones are just as good as the best private enterprises. Capable farm managers will be able to get a great deal out of cooperatives despite the structural

disadvantages. In the table below we report average value of the revenue per ha and per worker for ten most efficient and ten least efficient enterprises in each category.

Table 2. Results of economic activity for ten most efficient and ten least efficient enterprises

	Ten most efficient enterprises			*Ten least efficient enterprises*		
	Private enterprises	Agricultural companies	Cooperatives	Private enterprises	Agricultural companies	Cooperatives
Revenue per ha. thd. UAH	0.66	5.69	1.82	0.48	0.51	0.74
Revenue per worker. thd. UAH	15.71	30.91	19.90	6.23	4.52	6.21

Source: own calculations

The results in Table 2 reveal that the best cooperatives have higher values of revenue per ha and revenue per worker compared to private enterprises, even though on average they perform worse. This implies that managers have different skills and that despite structural shortcomings of cooperative ownership form some managers can probably function better in a cooperative than in a private or partnership setting.

We also estimated the effect of some factors on an enterprise's technical efficiency. As the determinants of technical efficiency we take the following variables: farm size (thd. ha), farm specialization[2] and fertilizer use in tons of effective ingredients/ha. The effect of the farm size on efficiency is found to be negative and significant. Thus, for agricultural enterprises in the central regions of Ukraine technical efficiency generally increases with a decrease in farm size. However, if we analyze the impact of farm size for each category separately the results reveal that the technical efficiency of cooperatives *increases* with the farm size, which means that cooperatives could gain efficiency by increasing their operations. The effect of the degree of specialization on efficiency is positive and significant, which implies that enterprises that are engaged in many activities simultaneously are less efficient than enterprises specializing in some particular activity (i.e. crop or livestock production). The effect of fertilizer use on technical efficiency is also positive and significant.

3 What drives productivity growth in Ukrainian Agriculture?

Technological change and efficiency improvement are the most important sources of productivity growth. To compute the change in productivity over the 1996-2000 period as well as its components (efficiency and technological change) we use a specific computer program[3].

[2] Specialization is calculated using the Herfindahl index which is defined as: $HI=\sum s_i^2$, where s_i is the share of i-th activity at the enterprise. The greater this index the greater the degree of specialization.

[3] For technical details see working paper No.20 "Efficiency of agricultural enterprises and productivity growth in agriculture", July 2003

The data for the analysis were taken from Derzhkomstat and the Ministry of Agrarian Policy publications and include gross value of production by agricultural enterprises in constant 1996 prices, the number of workers employed by agricultural enterprises, area of agricultural land, machinery power of agricultural enterprises and mineral fertilizers as the sum of units of effective ingredients. The data cover all 25 oblasts of Ukraine over the 1996-2000 period.

The results are reported in Table 3.

Table 3. Change in TFP and its components

	Average annual change			***Cumulative change over 1996-2000***			Average farm size, ha
	TFP[1]	Efficien-cy	Techno-logy	TFP	Efficien-cy	Techno-logy	
Western region[4]	0.943	0.947	0.996	0.794	0.807	0.984	617.1
North-Central region[5]	1.013	0.985	1.028	1.088	0.945	1.151	1545.5
South-Eastern region[6]	1.054	1.020	1.033	1.239	1.088	1.139	1860.1
Average for Ukraine	**1.007**	**0.987**	**1.021**	**1.060**	**0.964**	**1.092**	**1770.0**

[1]*- productivity of production factors employed in agriculture;*

Source: own calculations

The results reveal that productivity grew by only 0.7% per year on average in Ukraine between 1996 and 2000 with technological change contributing 2.1% to this growth and efficiency change contributing (–1.3)%. Hence, the modest annual increase in TFP in Ukrainian agriculture arose from the technological innovations, while technical efficiency was declining over time.

The performance of the Western oblasts was the poorest. A characteristic feature of agricultural development in these oblasts is a decline in technical efficiency by about 20% over the five year period combined with technological regress of 1.6%. Quite a different picture emerges for the South-Eastern region. Farm size is one plausible explanation for such a distinct pattern of agricultural development across regions. If one compares the average farm size in the Western oblasts with that in the South-Eastern oblasts (see column 7 in Table 1) one can notice that farms in the latter oblasts are about three times as large. The benefits of large farms come from easier access to public goods and services, easier access to credits and, consequently, modern technologies and technical efficiency improvements due to economies of scale. These benefits seem to outweigh the costs of large-scale production associated with difficulties in monitoring and motivating workers. Our finding is valuable for policy makers because it points to the importance of large-scale production in

[4] Western region include Volyn, Lviv, Traskapathian, Rivne, Ternopil, Ivano-Frankivsk, Khmelnytska and Chernivtsi oblasts

[5]North_Central region include Zhytomyr, Vinnitsa, Poltava, Chernihyv, Kyiv, Charkasy and Kirovograd oblasts

[6] South-Eastern region include Sumy, Kharkiv, Dnipropetrovsk, Zaporizzya, Donetsk, Luhansk, Odessa, Mykolaiv, Kherson oblasts and the Crimea

adopting new technologies and diffusing these technologies through the agricultural sector. Even though smaller farms are more technically efficient per se, large farms gain more from technological progress and their efficiency changes faster.

4 Conclusions and policy recommendations

Development patterns in Ukrainian agriculture are characterized by a deterioration of technical efficiency over time and only modest technological progress. More than a half of the 25 oblasts experienced a decline in productivity over the 1996-2000 period, which was primarily explained by less efficient resource use by agricultural enterprises. Over the period under study the technological progress was only modest. This result should be allowed for in developing future agricultural policy and calls for creation of favorable conditions for attracting foreign direct investments as a means of transferring innovations through Ukrainian economy. However, foreign technologies cannot be adopted one to one and must be adapted to Ukrainian conditions. To ensure that that these technologies are made the best possible use the government should also increase investments into research and training programs for farmers.

The economic efficiency of agricultural enterprises is very low. This implies that agricultural enterprises on average have poor abilities to use and allocate resources efficiently. To induce enterprises to allocate resources more efficiently the government should eliminate input market imperfections. As the government gradually eliminates controls and imperfections in input markets and creates a well functioning land market inputs will be increasingly free to "move" to the most efficient farms, and enterprises' allocative efficiency in Ukrainian agriculture will improve as a result. To increase technical efficiency the government should undertake measures to facilitate access to private capital markets, since capital-intensive farms in general appear to be more technically efficient. Low economic efficiency also indicates the need for market disciplines. Land markets and bankruptcy are two ways of making sure that inefficient enterprises lose control of important assets over time, so that the more efficient can expand.

Of the four forms of ownership studied cooperative is the least efficient form. This can alternatively be stated that managers of cooperatives achieve the lowest returns on each hryvna invested in production. Nevertheless, the best cooperatives perform just as good as the best private enterprises, which means that good management can compensate for structural shortcomings. This finding suggests that in Ukrainian agriculture structural changes are required and for these changes to occur market mechanism should function to force inefficient farms to exit and allow the efficient farms to succeed and expand.

V.G., S.D., Lektor S.v.C.-T., August 2003