PRODUCTIVITY AND EFFICIENCY OF CORPORATE AND INDIVIDUAL FARMS IN UKRAINE

Zvi Lerman
Department of Agricultural Economics and Management,
The Hebrew University of Jerusalem, Israel
lerman@agri.huji.ac.il

David J. Sedik
Regional Office for Europe and Central Asia,
Food and Agriculture Organization of the UN, Rome, Italy
David.Sedik@fao.org

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Abstract

The paper presents a comparative analysis of the productivity of corporate and individual farms in Ukraine based primarily on cross-section data from a farm survey conducted by FAO in 2005. We calculate partial land and labor productivity, total factor productivity, and technical efficiency scores (using Stochastic Frontier Analysis) for farms of different organizational forms. Our results demonstrate with considerable confidence that, contrary to established convictions among the Ukrainian decision makers, the large corporate farms are not more productive than the smaller family farms. This finding is not restricted to Ukraine, as a similar result has been obtained by in Moldova, Russia, and the U.S. Policies encouraging a shift from large corporate farms to smaller individual farms, rather than the reverse, can be expected to produce beneficial results for Ukrainian agriculture and the economy in general. The government of Ukraine should abandon its inherited preference for large-scale corporate farms and concentrate on policies to improve the operating conditions for small individual farms. At the very least, the government should ensure a level playing field for farms of all sizes and organizational forms, and desist from biasing its policies in favor of large farms.

Keywords: family farms, corporate farms, comparative performance, technical efficiency, total factor productivity, agrarian reforms, transition countries.

JEL classification: D24, J24, P27, P31, P32, Q12, Q15, R14

Introduction

One of the items on the agricultural reform agenda in former Soviet republics forming the Commonwealth of Independent States (CIS) involves transformation from the traditional corporate farms to substantially smaller family or individual farms. This transformation is motivated by the theoretical incentive analysis of farms of different organizational forms in market economies, which suggests that family farms can be expected to achieve higher levels of productivity and efficiency than corporate farms (Allen and Lueck 2002). Although Ukraine embarked on a course of transition to a market economy back in 1991, the first decade was largely characterized by political indecision and lacked clear strategic focus (Lerman and Csaki 2000). Agricultural land was privatized, but only in the form of paper certificates of ownership, without actual distribution of physical plots to rural families. It is only in 2000 that sufficient political resolve was mustered to initiate sweeping conversion of these paper certificates into physical plots. As a result the share of agricultural land in individual use increased dramatically from about 15% in the late 1990s to 45% in 2005.

Despite the impressive progress with family farming, the large corporate farms – a carryover from the Soviet era – still control more than half the agricultural land in Ukraine. Comparison of farm structure in Ukraine and in typical market economies shows that Ukraine is characterized by much greater land concentration in large corporate farms than the United States or any of the EU-15 countries. The Soviet agricultural ideology, which was driven, among other factors, by expectations of economies of scale, is still deeply implanted in the minds of all agricultural decision makers, regardless of their declared dedication to market economy principles. This ideology accounts for the widespread bias in favor of corporate farms and the emphasis on so-called “horizontal transformation”, which aspires to make persistently inefficient corporate farms suddenly efficient. Yet the experience of the last 15 years in all former Soviet republics shows conclusively that the attempts to preserve the large-scale corporate structures (whether as agricultural cooperatives or as new corporations with market-sounding names) have not produced any positive results. On the contrary, it is the three small countries that resolutely abandoned the large-scale corporate structures and made a clean shift to small-scale individual agriculture – Armenia, Georgia, and Azerbaijan – that demonstrate the most impressive recovery record among the CIS countries in recent years (Lerman 2004). Ukraine itself is beginning to show signs of agricultural recovery in response to the changes in farm structure since 2000.

This paper attempts to inform the ongoing policy debate between the supporters of large corporate farms and the supporters of smaller family farms in CIS. The paper presents a comparative analysis of the productivity of corporate and individual farms in Ukraine based primarily on cross-section data from a survey of 1,400 respondents conducted in 2005 by the United Nations Food and Agriculture Organization (FAO) with local support. We calculate partial land and labor productivity, total factor productivity (based on both accounting data and the production function approach), and technical efficiency scores (using a Stochastic Frontier algorithm) for farms of two main organizational forms: large corporate farms and relatively small family farms.

Our results unfortunately do not demonstrate clear-cut performance differences between corporate and individual farms, in part because in some analyses the individual sector is represented only by peasant farms, whereas household plots – the main component of the individual sector – are excluded due to missing data. Yet our results do demonstrate with considerable confidence that, contrary to established convictions among the Ukrainian decision makers, the large corporate farms are not more productive than the smaller family farms.

Moreover, the very small household plots – a major component of the individual farm sector – are resoundingly more productive than the large corporate farms. These findings for Ukraine are consistent with recent results for Moldova (Lerman and Sutton, 2006), Russia (Brock et al., 2007), and the United States (Ahearn et al., 2002), all of which demonstrate that large corporate farms do not perform better than small family farms. We do not observe economies of size among Ukrainian farms, just as we do not observed economies of size for farms in other CIS countries and in the United States.

Changing Farm Structure in Ukraine

The collective and state farms that dominated Ukraine's farm sector for decades during the Soviet era were notoriously inefficient (Lerman et al. 2004). The need for the reorganization of the traditional "farm enterprises" in the interest of improved productivity was recognized long before Ukraine became independent, and the country began the process of agrarian reform in March 1991, six months prior to the declaration of independence from the Soviet Union. The first Land Code of independent Ukraine passed in March 1992 included provisions for privatization of state land, abolishing exclusive state ownership, and the mechanisms for the division of the privatized land into individual land shares were finalized by presidential decree in August 1995.

Share-based privatization (similar to that in Russia) did not actually allocate land use rights to individuals. Rural residents received paper certificates of landownership ("land shares"), without physically getting a plot of land, and certificate holders were allowed to convert the land share into a private plot when leaving the former collective. By December 1999 more than 6 million rural residents had received paper certificates confirming their entitlement to a plot of land of a specified size (4.2 hectares on average) but in an unspecified location. The non-land assets (farm machinery, buildings, livestock) had been divided into value-based paper shares. The collective (now transformed into a corporate farm) was no longer a closed entity, as it had been during the Soviet era, and individuals were entitled to leave the collective taking their shares of land and assets with them. Yet very few corporate farms distributed land and assets in kind to the shareowners and few farm employees left the large farms for independent farming. The land and asset shares typically remained locked in collective ownership and use.

Share privatization did not encourage large farms to change their mode of operation by reducing costs (share privatization often resulted in only "changing the sign on the door"), nor did it eliminate the soft budget constraints implicit in government policies toward the large farms. Most importantly, perhaps, it did not resolve the barriers to exit from large corporate farms. Neither farm directors nor shareowners generally supported allowing other members to leave the farm. Many details of the exit procedure (allocation of land and asset shares, the methodology of identification of concrete plots of land and division of large farm assets) were worked out only years after the initial decrees authorizing farm exit. The relatively unfavorable conditions for individual farmers in matters of access to capital, inputs, and markets compared to agricultural enterprises dissuaded many from exiting the corporate farms.

For these reasons, the first-wave reforms implemented throughout the 1990s failed to produce the expected improvements in agricultural productivity and efficiency, and the second phase of agricultural reforms was launched by President Leonid Kuchma in December 1999 (Decree 1999). The 1999 presidential decree essentially forced the conversion of the share certificates into physical land plots, which could then be withdrawn by a simplified procedure and used to establish a new individual farm or to enlarge an existing household plot. Corporate farms could continue to use the privatized land only if they signed a formal lease contract with the landowners.

The second-wave land reform achieved some very important results for rural residents. First, nearly 7 million rural residents became owners of physical land plots (4.2 hectares on average), not just paper shares. About 70% of agricultural land, or 80% of arable land, is now physically owned by rural individuals. Ukraine evolved from exclusive state ownership of land in 1990 to a mix of state and collective ownership in 1993-95 and finally to a mix of state and private land ownership in 2000-05. The land ownership structure seems to have stabilized since 2000 with roughly one-half remaining in state ownership and one-half transferred to private ownership.

Table 1. Agricultural land by farm type (thousand hectares and percent)

	Total ag land	Corporate farms	Household plots	Peasant farms	Corporate farms, %	Household plots, %	Peasant farms, %	Individual sector, %
1990	42,030	39,357	2,669		93.6	6.4	0.0	6.4
1991	41,973	38,061	3,864		90.7	9.2	0.1	9.3
1992	41,930	36,747	4,833		87.6	11.5	0.8	12.4
1993	41,890	36,260	5,011		86.6	12.0	1.5	13.4
1994	41,862	35,764	5,357	741	85.4	12.8	1.8	14.6
1995	41,853	35,442	5,589	822	84.7	13.4	2.0	15.3
1996	41,840	35,240	5,694	906	84.2	13.6	2.2	15.8
1997	41,854	35,029	5,789	1,037	83.7	13.8	2.5	16.3
1998	41,827	34,806	5,919	1,102	83.2	14.2	2.6	16.8
1999	41,829	34,408	6,243	1,178	82.3	14.9	2.8	17.7
2000	41,827	30,941	8,543	2,342	74.0	20.4	5.6	26.0
2001	41,817	29,327	9,736	2,754	70.1	23.3	6.6	29.9
2002	41,800	27,940	10,939	2,921	66.8	26.2	7.0	33.2
2003	41,789	25,826	12,799	3,164	61.8	30.6	7.6	38.2
2004	41,764	24,524	13,819	3,421	58.7	33.1	8.2	41.3

Source: Derzhkomzem (various years).

The two reform waves have produced a significant redistribution of agricultural land between the individual and the corporate sectors of Ukrainian agriculture. The land holdings of the corporate sector consisting of former collective and state farms steadily shrunk between 1990 and 2004, while the individual sector grew by absorbing land from corporate farms (**Figure 1**).

The transfer of agricultural land from corporate to individual farms accelerated markedly in 1999. Thus, the share of the individual sector (household plots and peasant farms combined) in agricultural land use increased from 6% in 1990 to 17% in 1998 and then soared to 41% in 2004 (**Table 1**). The share of corporate farms decreased correspondingly from 94% of agricultural land use in 1990 to 59% in 2004. The increased share of individual farms in land use is reflected in increased holdings because the total agricultural land in Ukraine has remained constant at 42 million hectares.

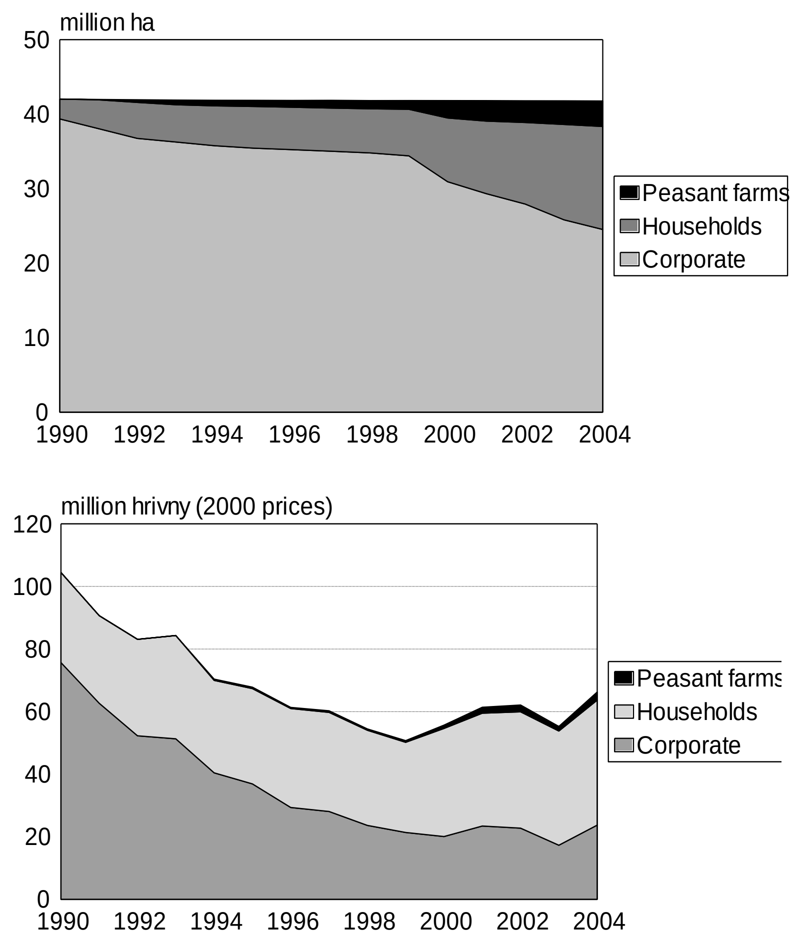

Figure 1. Agricultural land (top panel) and gross agricultural product in constant prices (bottom panel) by farm type in Ukraine, 1990-2004. Source: AgUkraine 2006.

The 1999 decree has dramatically changed the face of Ukrainian agriculture (**Figure 1**). From agriculture with predominant concentration of production in collective farms it has evolved into agriculture characterized by the clear dominance of individual farms. The individual sector (consisting of the traditional household plots and the independent peasant farms that began to emerge after 1992) controls today more than 40% of agricultural land, contributing 70% of agricultural output. Within the individual sector, the main contribution to agricultural production is from household plots, not peasant farms, as they also control much more land (33% versus 8%).

Ukrainian farms today can be classified into two broad organizational categories: individual farms and corporate farms (the latter are often called "agricultural enterprises"). The individual sector is subdivided into household plots and peasant farms. These are typical family farms and the main difference between them is one of size and commercial orientation. Household plots are generally smaller and more subsistence-oriented than peasant farms, but they sell their surplus products and thus augment the family income with sales revenue. Individual farms operate mainly on family-owned land, although growth is achieved by leasing additional land from other owners. The corporate sector consists of relatively large farms that have replaced the traditional collective and state farms in the process of reform since 1992. They are organized as private corporations with two or more shareholders (some farms have as many as 1,600 shareholders according to the 2005 FAO survey) that operate mainly on leased land and have strong commercial orientation.

The size of holdings in the individual sector has increased remarkably as a result of the 1999 reform. The average size of a family (peasant) farm increased from 25-30 ha in 1998 to 70-80 ha in 2003-2004. The share of peasant farms in agricultural land doubled from 2-3% in 1995-99 to 6% in 2000 and continued to rise to 8% in 2003-2004. The average size of household plots grew from about 1 hectare in 1998 to 2.5 hectares in 2004 as their share in agricultural land increased from 15% to 35%. The substantial increase in total land cultivated in household plots and their average size since 2000 is the direct outcome of the 1999 Presidential Decree, which made it possible for many rural residents to take their land share out of the former collective and use it to augment the traditional household plot (instead of establishing a peasant farm, as originally envisaged).

The increase of landholding in the individual sector has been complemented by a decrease in the landholding in corporate farms as well as an increase in the number of corporate farms. The average size of a corporate farm in Ukraine has fallen from 3,000 ha in 1990 to 2,000 ha in 1998 to 1,000 ha in 2004. Corporate farms are now mainly represented by limited liability companies and private lease enterprises (the latter accounting for almost 25% of the total number of corporate farms in Ukraine). While the number of shareholders in corporate farms ranges from 1 to 1,600, fully 16% are single-shareholder entities and 31% have from 1 to 3 shareholders only.

Despite these changes, there remain important differences in the size distribution of farms in Ukraine and in market economies. First, the average size a household farm in Ukraine (2.5 hectares) is much smaller than the average family farm in market economies (130 hectares in land-rich United States, 20 hectares in EU-15). Second, the average size of a corporate farm in Ukraine (around 1000 ha) is still quite a bit larger than the average size of farms in the EU and the United States. Even non-family corporate farms in land rich United States (about 0.3% of farms using 1.0% of land in farms) are on average only 533 ha in size (USDA/NASS 2004). Though there has been an impressive fall in the average size of corporate farms in Ukraine particularly since 1999, there is still some way to go before the size of Ukrainian corporate farms becomes consistent with farm sizes in market economies. As a result of these differences, the concentration of land use in Ukraine continues to deviate substantially from that in established market economies: it is still characterized by Soviet-era duality, with a large number of very small farms controlling a minute proportion of agricultural land and a very small number of large farms controlling a disproportionately large land area.

Farm Productivity: Prior Hypotheses

Productivity is the output produced per unit of resource used, and it is accordingly a measure of the efficiency with which producers use available resources. Productivity measures are at the core of the discussion of the impact of reforms in transition countries, as efficiency improvement was the main motivation for the shift from the centrally controlled socialist economy to the market economy. The main manifestation of market reforms in Ukraine and other CIS countries involves a shift from traditional corporate farms to new individual farms, and the study accordingly focuses on a comparison of productivity measures for corporate and individual farms.

We distinguish between partial productivity measures, when output is measured in relation to a single input (land, labor, machines) and total factor productivity (TFP), when output is measured in relation to a whole bundle of inputs used. In partial productivity measures the resource inputs are typically in physical units (hectares of land, number of workers, number of tractors or harvesters), whereas in TFP the different inputs are aggregated into a single bundle in money units. Aggregate output (the sum total of commodities produced) is expressed in units of value (although in some partial productivity calculations the specific commodity outputs may be expressed in physical units).

In addition to partial and total factor productivity, technical efficiency is often used to evaluate farm performance. Technical efficiency (TE) essentially measures the distance of a particular farm from the production frontier (the locus of points that represent the maximum attainable output for a given basket of inputs or, conversely, the minimum basket of inputs required to attain a given output).

Our prior hypotheses regarding productivity and technical efficiency measures used in this study are suggested by the available literature and theory. For partial productivity measures, our prior hypothesis is that individual farms (household plots and peasant farms combined) achieve higher productivity of land and lower productivity of labor than corporate farms. Higher productivity of land is usually attributed to greater incentives in the individual form of organization, while lower productivity of labor is associated with the tendency of individual farms to absorb labor (the "labor sink" effect of individual farms, see Lerman and Schreinemachers (2005)). The potential ambiguity in performance ranking by partial productivity measures is expected to be resolved by TFP. Our prior hypothesis for total factor productivity is that individual farms achieve higher TFP than corporate farms, primarily due to differences in incentives between the two forms of farm organization. For technical efficiency our prior hypothesis is again that individual farms achieve higher TE scores that corporate farms for the same reasons.

The various productivity measures and technical efficiency scores of corporate and individual farms in Ukraine are calculated using cross-section data from a survey of corporate and individual farms conducted in 2005 by FAO in cooperation with local counterparts (the 2005 FAO survey).

Partial Productivity of Land and Labor

We calculate the partial productivity measures as value of output per hectare of land (partial productivity of agricultural land) and value of output per worker (partial productivity of agricultural labor).[1] In accordance with our prior hypothesis, we expect the three organizational forms to be ranked by output per hectare in the order household plots > peasant farms > corporate farms. The actual results for the productivity of land in farms of different types are presented in **Table 2**. Household plots outperform both peasant farms and corporate farms by partial productivity of land (parametric *t*-test for means, nonparametric Wilcoxon test for medians). The differences between corporate farms and peasant farms are not statistically significant (both tests). The survey thus produces the ranking household plots > peasant farms ≈ corporate farms by partial productivity of land.

Table 2. Partial productivity of land and labor in farms of different types

	Land productivity, '000 hrivny/ha		Labor productivity, '000 hrivny/worker	
	Mean	Median	Mean	Median
Corporate farms	4.4	0.9	17.4	12.5
Peasant farms	4.8	1.0	11.7	5.9
Household plots	11.8	5.0	--	--
All sample farms	8.8	2.3	14.0	8.1

Partial productivity of agricultural labor was calculated only for corporate and peasant farms, as the number of farm workers could not be reliably estimated for household plots. While the productivity of land is comparable for corporate and peasant farms, the productivity of labor (**Table 2**) is significantly higher for corporate farms (as expected). This is consistent with the "labor sink" effect of individual farms: in Ukraine peasant farms surveyed employ nearly 30 workers per 100 hectares compared with less than 20 workers per 100 hectares in corporate farms.

[1] Partial productivity of land was also calculated in terms of crop yields in physical units (kg per hectare). Because of the large number of commodities involved (16 different crops), the comparison results for farms of different forms are not clear-cut, but judging overall ("by majority") household plots are doing better than either corporate or peasant farms. On the other hand, corporate and peasant farms overall achieve comparable crop yields. Milk yields – a partial productivity measure for livestock – are lower for corporate farms than for individual farms (2,600 kg per cow per year compared with 3,750 kg per cow per year), but there are no statistically significant differences between the two components of the individual sector (household plots and peasant farms).

The partial productivity of land decreases with farm size (**Table 3**). The decrease is particularly strong for the small household plots and levels out for the larger peasant farms and corporate farms. Yet for these larger farms also the size coefficient is negative and statistically significant. Thus, in a regression framework, large farms have significantly lower land productivity than smaller farms even when the comparison excludes household plots and is restricted to peasant farms and corporate farms only. The partial productivity of labor, on the other hand, increases with farm size, rising significantly from the smaller peasant farms to the larger corporate farms (no labor data for household plots).

Table 3. Regression coefficients for land productivity and labor productivity versus farm size

	All three farms types	Household plots only	Peasant and corporate farms
Land productivity	−0.292	−0.508	−0.092
Labor productivity	--	--	+0.265

Note: All coefficients statistically significant at $p < 0.01$.

Figure 2 shows the output per hectare as a function of size for all three farm types. It visually demonstrates the results of **Table 2**, where household plots > peasant farms ≈ corporate farms. On average household plots have higher land productivity than peasant and corporate farms, but the regression results in **Table 3** show that land productivity decreases with size also in the subsample of peasant and corporate farms (the relatively flat right-hand tail of the scattergram in **Figure 2**).

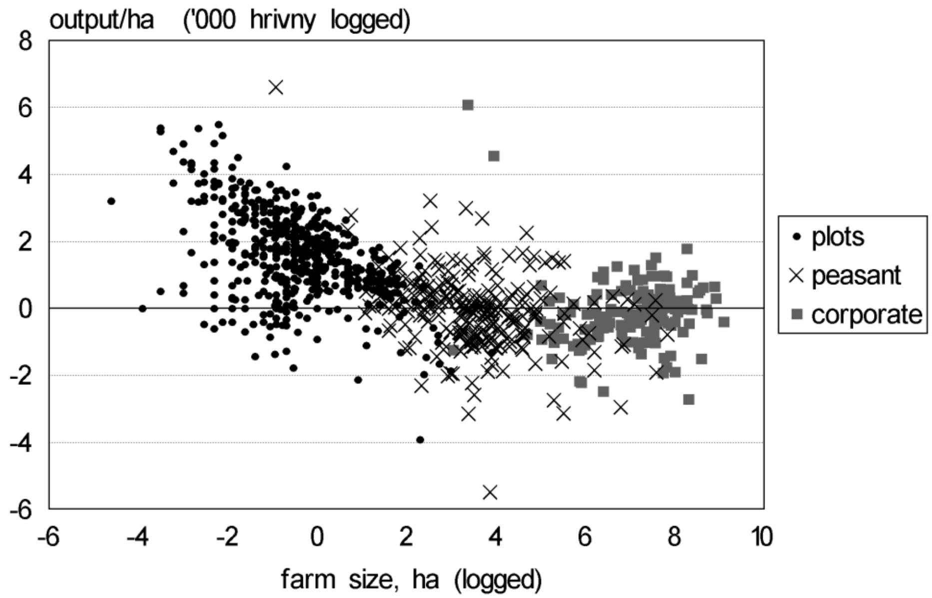

Figure 2. Output per hectare as a function of farm size (in logged variables). Source: 2005 FAO survey.

Total Factor Productivity (TFP)

The two partial productivity measures for land and labor do not give a consistent picture: individual farms have a higher productivity of land and a lower productivity of labor. This ambiguity can be resolved by switching from partial productivity measures (each calculated for a single input) to total factor productivity (TFP), which is calculated as the ratio of the aggregated value of output to the aggregated cost of input use. The theoretical formula for the aggregated cost of input use calls for multiplying the quantity of each input by its market price and summing all the input cost components. This is a truly formidable undertaking in most cases, and a naïve method equates input costs to production costs as reported in the farm's financial statements. The ratio of sales to costs is a TFP proxy that provides a strictly accounting measure of productivity and is in fact equivalent to profit margin.

The well-known accounting valuation biases can be avoided even in the absence of market prices for valuing the cost of inputs (such as the price of land). A theoretically more sound approach is to determine TFP by estimating a production function and then using the estimated input coefficients as the weights to calculate the value of the bundle of inputs. The ratio of the observed output to the estimated bundle of inputs is the TFP. This measure does not use accounting data and does not require knowledge of market prices.

In principle, the production function should be estimated for all the relevant inputs. In farm surveys, however, the proliferation of missing values dramatically reduces the number of valid cases that can be used for estimation as the number of inputs is increased. The problem is especially acute because the standard Cobb-Douglas production function is estimated in logarithms, which are undefined whenever the corresponding input is zero. In total, there are 518 observations of corporate and peasant farms in the survey database. Of these 507 observations have valid data on agricultural land and agricultural labor, but only 399 cases have data for the value of production – the dependent variable in production function estimation. This maximum number of observations (399) is actually available for estimating two-input production functions with land and labor as the only inputs. However, the number of valid observations is reduced from 399 to 371 if in addition to land and labor we also include farm machinery, to 302 if we add fertilizers to the list of inputs, and to 283 if both fertilizers and diesel fuel are included. Thus, with merely 5 inputs – land, labor, machinery, fertilizer, and diesel fuel – we lose 30% of the potential number of observations (399). Data shrinkage is even more dramatic if we include the number of animals as an input: production function estimation using land, labor, farm machinery and animals is based on as few as 207 observations.

In the general economic literature, TFP is typically calculated assuming two inputs: capital and labor (see, e.g., Jones, 1998, pp. 41-42). We have decided to follow a modification of the same approach from considerations of data availability and reliability. In our estimations labor is taken as the physical number of agricultural workers reported in the survey (in preferences to salaries) while capital is proxied by two physical variables: agricultural land (in hectares) and the aggregated number of pieces of farm machinery (in preference to the highly uncertain balance sheet value of machinery). The livestock herd was excluded from the capital component because of the large number of farms without animals. We thus estimated the production function with three inputs: labor, land, and farm machinery. A separate estimation was additionally carried out for the subgroup of farms with animals. The physical variables were judged to be much more reliable and consistent than the accounting figures reported for other factors of production, such as the cost of purchased inputs and the value of fixed assets (especially for individual farms).

Accounting-Based TFP

The survey provided fairly detailed accounting information on production costs for both corporate and peasant farms (no cost data were available for household plots). Corporate farms reported the production costs from their profit-and-loss statement. Total production costs in corporate farms included the cost of material inputs, labor costs, depreciation, and other costs. Peasant farmers, on the other hand, reconstructed mainly their material costs (including lease payments and taxes), but did not show labor costs or depreciation. To achieve comparability of the cost figures, the costs for corporate farms were adjusted to reflect only the cost of material inputs plus other costs (excluding labor costs and depreciation).

Table 4. TFP estimated by ratio of output to accounting costs

	Peasant farms	Corporate farms*
Value of output/production costs	1.51 (*n* = 223)	1.29 (*n* = 122)
Sales revenue/production costs	1.53 (*n* = 248)	1.22 (*n* = 143)

*Costs for corporate farms do not include depreciation and labor.

Table 4 presents the accounting-based TFP proxies calculated using these costs and two output variables: the value of production and the sales revenue. The results are weighted averages, obtained by taking the ratio of the sum total of outputs to sum total of input costs in the entire sample (the number of observations for each sum is shown in parentheses). The accounting TFP is somewhat higher for peasant farms than for corporate farms. There is no way to decide if the difference is significant, because weighted averages do not lend themselves to statistical significance testing.[2]

Production Function Approach: TFP by Dummy Variable Estimation

Differences in TFP between categories of farms can be captured by estimating appropriate production functions with a dummy variable for different farm types. If the dummy coefficient for type A farms is found to be greater than for type B farms, this implies that type A farms produce a greater value of output at any given bundle of inputs and essentially means that type A farms have higher TFP than type B farms. This procedure enables us to assess *differences* in TFP without actually calculating the TFP in *absolute values*.

Table 5. Estimation of Cobb-Douglas production function for corporate and peasant farms

Dependent variable: value of output ('000 hrivny, logged)	Model 1: labor, land, machinery*	Model 2: labor, land, machinery, animals**
Explanatory variables:		
Labor (workers, logged)	0.542	0.548
Land (ha, logged)	0.512	0.367
Farm machinery (pieces, logged)	0.175	0.067
Livestock (standard head, logged)	--	0.187
Farm type (dummy): corporate relative to peasant farms	−0.249	−0.318
R^2	0.815	0.848
Number of observations	371	207

* All coefficients significant at $p = 0.05$. Farm dummy marginally significant with $p = 0.18$.
** Labor, land, and livestock significant at $p = 0.05$; farm machinery ($p = 0.54$) and farm type ($p = 0.24$) not significant.

[2] Accounting-based TFP measures have been previously calculated in several studies for other transition countries. For a calculation of TFP as the ratio of output to the reported cost of inputs see Dudwick et al. (2005).

A three-input Cobb-Douglas production function, relating the aggregated value of output to agricultural land, agricultural labor, and the number of farm machinery, was estimated on 371 observations from the survey dataset classified into corporate and peasant farms (**Table 5**, Model 1). Another model (Model 2) was estimated with the number of animals also included in the capital component, but at the cost of using a much smaller sample of observations (207 farms with a nonzero herd). In both models the dummy variable differentiated between corporate and peasant farms, as household plots could not be included due to missing data for labor and other inputs.

In the three-input production function (Model 1), labor, land, and farm machinery have a highly significant positive impact on the value of production. In the four-input production function with livestock (Model 2), land and labor remain highly significant, but livestock takes over from farm machinery as the third significant factor of production in farms that have animals. The farm type dummy has a negative coefficient in both models (and in models with many other combinations of inputs that we have tried). This coefficient is only marginally significant (at $p = 0.20$) in Model 1 and not statistically significant by any acceptable measure in Model 2. Nevertheless, its consistently negative sign provides an indication that, for every given bundle of inputs, corporate farms achieve a lower value of output than peasant farms.[3] However, even without drawing this (statistically weak) conclusion in favor of the performance of peasant farms, we can definitely say that the results do not support the inherited socialist conviction regarding the superiority of large farm enterprises: the statistical analysis shows that corporate farms certainly do not outperform peasant farms. The performance of large corporate farms at best is comparable to the performance of the much smaller peasant farms.

[3] The mathematics of the Cobb-Douglas production function translates the negative dummy variable coefficient of −0.249 in Model 1 into a difference of 22% in output between corporate farms and peasant farms for each bundle of inputs ($1 - \exp(-0.249) = 1 - 0.78 = 0.22$). For Model 2 the difference is 27%.

Production Function Approach: TFP Calculated from Factor Shares

The estimated production function provides another technique for calculating the TFP in absolute values for different groups of farms. As we move from the relatively small peasant farms to the large corporate farms, the agricultural product increases, but so do the labor force, the land endowment, and the machinery pool. The production function is a mathematical relationship that links the increase in agricultural product with the increase in aggregated input use. The inputs are aggregated by applying the weights (or factor shares) from the corresponding production function to specific values of the inputs. TFP is calculated as the aggregated value of output divided by the aggregated value of inputs. In this sense it is similar to the standard partial productivity measures, in which the aggregated value of output is divided by the quantity of a single input (land or labor).

Table 6. Regression coefficients and input weights in alternative production functions

	Model A: labor, land, machinery	Model A weights	Model B: labor, land, livestock	Model B weights
Labor	0.511	0.44	0.538	0.50
Land	0.488	0.42	0.403	0.37
Farm machinery	0.168	0.14	--	--
Livestock	--	--	0.142	0.13
Sum of coefficients	1.167	1.00	1.083	1.00
R^2	0.814		0.843	
Number of observations	371		215	

Note: The estimated coefficients are significantly different from zero ($p< 0.01$); all sums of coefficients significantly greater than 1.

Table 6 presents the estimated production function coefficients and the weights used in TFP calculations (to calculate the weights the regression coefficients are divided by the sum of the coefficients, which in practice is not necessarily 1). Model A corresponds to Model 1 in **Table 5**, but without the farm type dummy. This is a three-input production function estimated for the pooled sample of corporate and peasant farms (n = 371 observations). Model B corresponds to Model 2 in **Table 5**, but it is also a three-input model with labor, land, and livestock: farm machinery has been omitted from the regression because its coefficient is not statistically significant. In both three-input production functions agricultural land accounts for nearly 50% of input use and labor for around 40% (see the columns for input weights in **Table 6**). The third factor (machinery or livestock) accounts for less than 15% of input use. The aggregated value of inputs is obtained for each observation as the sum of the relevant inputs (labor, land, machinery or labor, land, livestock) multiplied by the respective weights from **Table 6**. The TFP is then calculated for each observation as the ratio of the value of output to the aggregated value of inputs.

The mean and median TFP values obtained by this method for corporate and peasant farms are presented in **Table 7**. The numbers are very close for the two categories and the differences between farms of different types are not statistically significant. Regression of TFP on farm size as a continuous variable (measured in hectares of agricultural land) failed to detect any statistically significant relationship either:TFP was found to be at the same average level for farms of all sizes. These results are fully consistent with the previous observation that the dummy variable coefficient did not produce a statistically significant shift in production functions between corporate and peasant farms. The TFP calculations do not provide positive evidence in support of our hypothesis that individual (peasant) farms are more productive than corporate farms. On the other hand, these results establish convincingly that corporate farms are not better than peasant farms, and both farm types should be allowed to evolve on a level playing field.

Table 7. TFP ('000 hrivny per aggregated unit of inputs)

	Mean		Median	
	Peasant farms	Corporate farms	Peasant farms	Corporate farms
Model A: labor, land, machinery	2.70	2.46	1.64	1.85
Model B: labor, land, animals	2.97	3.01	1.92	2.21

Note: none of the pairwise differences in TFP are statistically significant.

Technical Efficiency

Our approach to total factor productivity has mainly relied on estimation of production functions. A different approach that focuses on farm technical efficiency (rather than TFP) relies on the construction of production frontiers (not production functions). A production frontier is the locus of efficient or “best attainable” points, i.e., points where the maximum output is achieved for every given bundle of inputs, or alternatively every given output is achieved by the consumption of a minimum bundle of inputs. The production-frontier approach provides an alternative view that generally reinforces the TFP results obtained with production functions.

The production frontier is constructed on the basis of available empirical data, and the efficient points are the “best attainable” in the sample, not in the entire conceivable population. Once the production frontier has been constructed, the technical efficiency of each farm is calculated by measuring its relative distance from the frontier. Points on the frontier are technically efficient; their distance from the frontier is 0, and their technical efficiency (TE) score is 1. As the distance of a particular point from the frontier increases, its TE score decreases. Each TE score is a number indicating the output that a particular farm achieves with a given bundle of inputs as a fraction (or a percentage) achieved by the “best performer” with the same bundle of inputs. For a comprehensive discussion of technical efficiency and the methodology of constructing production frontiers see Coelli et al. (1998).

Stochastic Frontier Analysis (SFA) is a production frontier technique that is conceptually close to production function estimation. This is an econometric method that starts with the production function and then iteratively shifts it outward by a certain algorithm until a production frontier is obtained. The actual observed points generally fall below the frontier (in this sense they are inefficient). The deviation of the observed points from the frontier also contains a random error component because of which some points may actually fall above the estimated frontier (if the error component exceeds the estimated inefficiency component). The TE scores are calculated by taking the ratio of the actual output of each farm (adjusted for random errors) to the stochastic frontier output for the corresponding bundle of inputs. A detailed description of the SFA algorithm can be found in Coelli et al. (1998).

For Ukraine we could only analyze the technical efficiency of corporate and peasant farms, because there were practically no labor data for the small household plots (see **Table 2**). The SFA algorithm was applied to construct three stochastic frontiers: a frontier with only two inputs (land and workers), a frontier with three inputs (land, workers, and number of farm machinery), and finally a frontier with four inputs (including also livestock). The number of valid observations decreased as the number of inputs was increased (**Table 8**). As the output in all three models we used the value of production calculated on the basis of survey data.

Table 8. TE scores for farms of different organizational forms

	Number of observations	Corporate farms	Peasant farms
Two inputs: land and workers	398	0.719*	0.685*
Three inputs: land, workers, number of machines	371	0.714*	0.684*
Four inputs: land, workers, machinery, livestock	207	0.710	0.687

Note: TE scores estimated by SFA with organizational form as Z factor.
*Differences in TE scores statistically significant at $p = 0.01$.

In all three models, the TE scores for corporate farms were higher than those for peasant farms (contrary to our hypothesis), but in the four-input model the difference between organizational forms was not statistically significant. The conclusion is basically the same as for TFP calculations above. The overall situation is similar to that observed previously for Russia (see Brock et al. (2007)), where peasant farms did not outperform corporate farms and only household plots (missing from the Ukrainian analysis) had higher TE scores.

The frequency distribution of the SFA efficiency scores for Ukraine (**Figure 3**) on the whole is similar to that for Russia, with most farms bunching fairly close to 1 (the mode is at

0.72-0.80 in all three models). Because of lack of statistical significance in the differences between corporate and peasant farms, the distributions for the two organizational forms cannot be resolved into two distinct histograms.

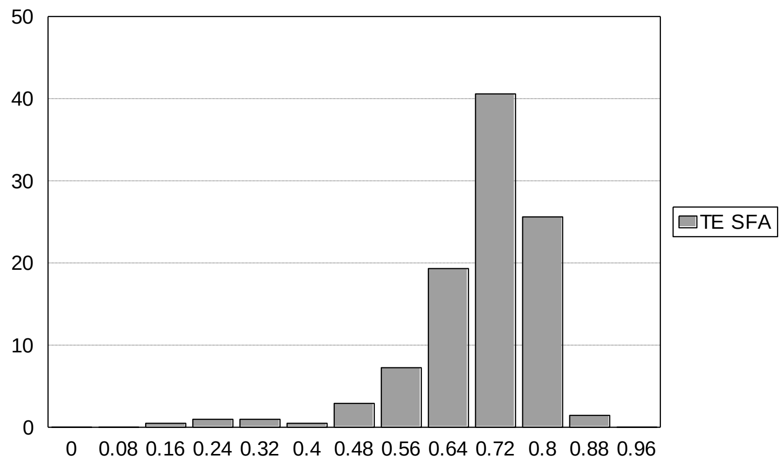

Figure 3. Frequency distribution of technical efficiency scores for corporate and peasant farms (SFA with four inputs: land, workers, machinery, and livestock). Source: 2005 FAO survey.

Conclusions

We did not observe clear-cut performance differences between large corporate farms and the much smaller peasant farms (unfortunately no comprehensive performance data on the very small household plots were available for Ukraine). The information available from the 2005 FAO farm survey in Ukraine did not provide convincing and unambiguous evidence in support of the basic hypothesis of reform advocates, namely that the individual farms arising in the process of reform are more efficient than the conservative corporate farms. These results are somewhat surprising, because they contradict recent findings for both Moldova (Lerman and Sutton 2006) and the United States (Ahearn et al. 2002), where smaller farms achieved higher TFP than larger farms, providing an indication of diseconomies of size.

Our conclusion for Ukraine at this stage is limited to a more modest result, namely that we do not observe economies of size operating among Ukrainian farms. The conclusion in itself has important implications in a country where the traditional mindset among agricultural policy-makers is that "large is beautiful". Based on our findings, there is no justification for continuing policies that favor large corporate farms over smaller family farms. The government of Ukraine should abandon its inherited preference for large-scale corporate farms and concentrate on policies to improve the operating conditions for small individual farms. All types of farms should be allowed to evolve on a level playing field, as they normally do in established market economies. Continuing the transformation from largely corporate to largely individual farm structure in line with the patterns characteristic of market economies can be expected to strengthen the beneficial effects for Ukrainian agriculture that are beginning to be noticeable since the introduction of the watershed policies in 2000.

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