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STRUCTURAL UKRAINIAN AGRARIAN CHANGES: NUMERICAL EVALUATION

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This article was focused on issue of Ukrainian agricultural producers' data analysis. The main tendencies of Ukrainian agrarian sector development were discovered and shown in this study. It was detected that the size of agricultural enterprises is growing in Ukraine and it leads to the negative results in the social sector. The main reason of enterprises growing process was shown. It is connected with some institutional advantages which specified by enterprises size growing.

Keywords: the efficiency of agricultural production, scale economics, agricultural risks

1. Introduction

The vector of the Ukrainian agricultural sector reforming and development remains extremely important issue and generates heated discussion in society. On the one hand, we are proud that Ukraine is a big player on the global food market, exports significant amounts of grain production. On another hand the food security of Ukraine remains unresolved problem. Significant amounts of animal products, gardening, etc. are imported (including the products, which are traditionally produced in Ukraine). In addition, many questions are focused around the issue of

social development of the village. The absolute majority of the rural social development indicators are significantly lower than similar indicators in city [1]. We can assume that the vectors of economic and social development of rural are more likely opposite. Therefore, considerable interest for us represents direction in which rural areas are developing and the structural changes that are occuring in Ukrainian agriculture.

From the beginning of 1991, the active discussion about the reforming of agricultural sector is going in Ukraine. When the Agrarian Reform had been lunched, it had been considered, that exactly farmers had to create the basis of agricultural production in Ukraine [2]. The former chief of Agrarian economics institute T. Sabluk mentioned: "Especially this type of management is appropriate for Ukraine because it had been tested by the international practice" (European model of agricultural production). However, author had not discussed the institutional conditions for farming development and external impact on this process. For comparison, in the U.S.A. 2.6% agricultural producers in 2007 produced 58.7% of all agricultural commodity products [3]. It is clear that in accordance with the international practice, farming is not a guarantor of food security, and the productivity efficiency of large enterprises cannot be questioned [4]. Recently big agrarian enterprises proved their efficiency as grain producers. But some researchers noted: "It is impossible to conclude about the benefits of some form because the period of their activity is too short…". Therefore, the main task of small farmers is "... to find their own niche in agriculture ..." [5].

The numerous Ukrainian studies paying attention to the most effective commodity producing forms' choice between farming, enterprises and households. The agricultural land market does not exist in Ukraine. The problem of land price determination (the main topic of the Ukrainian agricultural economists' discussions) is resolved by administrative (not market) methods. The future reform should open the land market and allow selling or buying the lands. It could happened that because of low land price, main part of householders' lands would be transited to powerful agricultural enterprises, which are most effective producers currently. Such scenario could be the reason of deepening of the rural social problems [6]. However, for analysing the benefits of various forms, most of Ukrainian studies are using only indicators of economic efficiency of production. The objective function of each company defined by profits or profitability maximization [7]. In contrast, not enough attention paid to the risks of agricultural productivity and reactions of producers on them, while this criterion is essential in the case of uncertainty inherent in agricultural production (state agricultural policy, weather and price fluctuations).

For example, in the case when maximum economic efficiency is achieved by highly specialized agriculture enterprises, the negative impact of risks on the result may endanger the food security in Ukraine. Neglecting hazards and reaction on

them may result incorrect estimation of economic efficiency parameters, as was shown in the research of Bokusheva R. and G. Hokhman [8]. The authors noted that in accordance with the experience of the world agricultural producers crop failure risk minimization or profitability maximization on the given level of significance should be choosing as the target function.

In the study of M. Roberts and N. Kay on example of USA was shown that the total numbers of agriculture companies has certain limits, and the structure of enterprises (number of large, medium and small) has clear tendency to the size increase. Variation of the structure happens almost due to the external shocks (natural and market) that influence on the productivity efficiency. Moreover, the positive shocks (good weather condition, high yield) leads to increasing of small farms number in the productivity structure, negative shocks (lean years, natural disaster) lead to increase of large enterprises number. The process of the production restructuring has more stationary features [9]. The term "scale economy" exists in the modern economy. It shows the enterprise size influence on production efficiency [10, 11].

Therefore, it is important to analyse the Ukrainian agricultural production transformation process, and to find which type of companies now has more benefits in terms of economic efficiency and risks. The purpose of this paper is to analyse the process of structural changes. We have to take into account unfinished institutional reforms, imperfect agricultural markets and governance. The research is based on statistical and econometrical analysis of agricultural business unites main input and output production characteristics.

2. Used information

Development of the Ukrainian agricultural production was considered in this study based on the official data of the "State Statistics Service of Ukraine" (SSSU). Information covers all agricultural companies that reports according to the form of reporting "50-sg" in the years 2007-2010 [12]. The total number of agrarian enterprises that represents sample is between 9000-9180. Each company was represented by the following information agricultural land area (ha – hectares), arable land area (ha), cultivated land area (ha), yield (cwt – centum weight 100 kg.) production costs (thousand UAH), cost of sales (thousands UAH), the total cost of sales (thousands UAH), volume of sales (cwt) sales (thousands UAH). Each enterprise was anonymous, it was impossible to determine its development. In 2007-2010 there was information only about wheat production, in 2010 information was about wheat, barley, corn, oats, sunflower, rapeseed and sugar beet production. For data analysis it was used IBM SPSS Statistics package.

3. Results of analysis

Firstly, we did selection of enterprises in accordance with $\bar{x}_{0,1}$ quartile of arable land in 2007-2010 years (the sample of 10% of enterprises with the largest area). According to the distribution function, it was the companies with the arable land size more than 3795 ha in 2007. Grouped data is presented in Table. 1. The calculations showed that in Ukraine exists a stable tendency of the large enterprises number increasing. The number of enterprises with the arable land area more than 3795 hectares increased in 13.8% from 2007 to 2010. In fact, 10% of agricultural enterprises in Ukraine are controlling 42.9% agricultural areas.

Table 1. Ukrainian agriculture producers consolidation dynamics

Years	2007	2008	2009	2010	Changes in 2010 compare to 2007
Number of 10 % largest arable land holders	829	913	929	943	13,8 %
Part of largest arable land holders in total number of enterprises, %	10 %	10 %	10 %	10 %	-
Arable lands in use of largest land holders, millions hectares	6,03	6,9	7,12	7,6	26 %
Part of arable lands in enterprises use	38,97 %	40,57 %	41,55 %	43,69 %	4,72 %
Part of agricultural lands in enterprises use	37,88 %	39,7 %	40,7 %	42,9 %	5,02 %

Source: own calculation based on SSSU data

In order to complete the process of the largest land users' group formation, we need only a land market in Ukraine. Because of the legal restrictions on the agricultural land market, the price of land remains unknown. These issues are keenly debated in scientific circles, but the fact of market absents impeded the agriculture development and negatively affected on rural development. During the analysis of international studies, it was shown that the large commodity company's size growth is the result of the negative economic shocks or natural disasters [9]. Under incompleteness of institutional reforms, imperfections of government regulation and instability of the financial system, farmers are under the influence of negative economic shocks that enhance weather risks inherent to agricultural [13]. Under the shocks influence, the consolidation process is an effective form of counter negative shocks action.

The structure of enterprises profitability that produced from 1 to 7 crops in the year 2010. As criterion of profitability, we consider the net profit per 1 ha of production. The sales revenue (UAH), total cost of sold production (UAH), area of crops (ha) were taken into account during the calculation. UAH exchange rates were approximately 10-10.5 UAH/EUR and 8-8.2 UAH/USD during the years 2010-2012. The area of crops remains unknown because of lack of information, but we know the volume of sales (cwt), total area of crops (ha), yield (cwt) and output cost (UAH). To calculate the area of sales we use yield and full spending per 1

hectare (UAH). The net profit per 1 hectare is presented in the frequencies chart (Figure 1.A). On the figure data is grouped with fixed (1000 UAH) increments of profit. Histogram was constructed from 6936 data points (2244 points were rejected because different reasons). Average net profit per 1 ha in 2010 was 680 UAH, and the standard deviation was 1371 UAH, it caused a significant variation of the sample (minimum is - 13.1 thousand UAH per 1 ha, up 37.8 thousand UAH per ha), the coefficient of variation is 202%. Because of this, increment of grouping had been chosen too high (1000 UAH / ha), and all low-profitable enterprises were "absorbed" in the first group. Therefore, to get a meaningful result from sample was not possible.

To be able to implement a graphical representation of distribution we made the transition of profits to a logarithmic scale. Thus, the frequencies for businesses with annual revenues that are range from -1 to 1 UAH per hectare are calculated separately. The calculated net profit on logarithmic scale is on Figure 1.B.

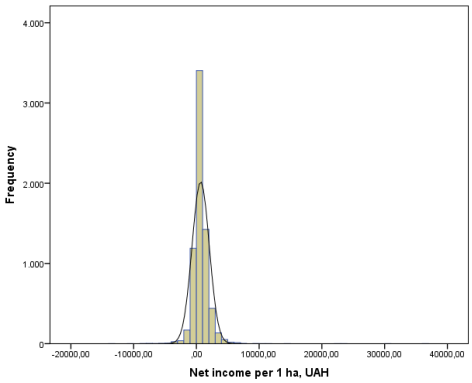

Figure 1A. Histogram of frequency distribution of net profit per 1 ha in 2010 year (linear scale)

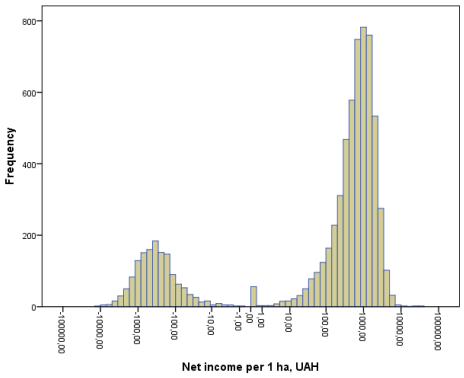

Figure 1B. Histogram of frequency distribution of net profit per 1 ha in 2010 year (logarithmic scale)

Transition to the logarithmic scale allows us to reduce the increment of histogram grouping criteria and clarify the main features of the unprofitable and profitable enterprises distribution. There were two main categories of enterprises producing from 1 to 7 crops (two-modal distribution): unprofitable enterprises with maximum frequency at losses 240-320 UAH (30-40 USD) per 1 ha and profitable with maximum frequency at profits 1600-2000 UAH (200-250 USD). In addition, pursuant to the distribution function (which was calculated separately) unprofitable agrarian enterprises accounts up to one-fourth of all enterprises in Ukraine. Similar calculations were performed separately for the production of wheat during 2007-2010. Results showed that there is no dynamics of the number of unprofitable enterprises reducing, and their share, which in 2007 was one-fourth, does not

changed in 2010. It means that in the Ukrainian agrarian sector structural changes are undergoing slowly, it leads to some improvement in production efficiency, but the share of unprofitable enterprises remains significant.

The total list of risks inherent to agriculture in developed countries was shown in the well-known study of Dana Hoag [14]. The list of risks that exist in developing countries substantially bigger, but we will focus only on the risks of productivity and profitability.

Let us explore the issue of profitability and risks from two different points of view: arable lands size and spending per 1 ha for one crop. We started from expenses (UAH) per 1 ha of wheat in 2010. Data was grouped according to the cost for 1 ha with increment in 500 UAH from 0 to 5500 and more UAH. Then C_i – average production expenses of i "cost group". The weighted average yield (cwt/ha); weighted average spending for 1 ha of crops (UAH), the average price of production realization (UAH / cwt), standard deviations and the number of enterprises were shown at Table 2.

Table 2. Data grouped by spending per 1 ha

No. of group	Upper and lower limits	Number of enterprises in groups	Average spending per one ha in UAH (st. dev.)	Average crops lands, ha (st. dev.)	Average yields in cwt per ha (st. dev.)	Average price of production realization UAH/M.T.	Risks of 0 net profit	Risks of negative profit	Distribution function enterprises in groups
1	0 - 500	70	357,3 (355,4)	152,6 (284,5)	10,69 (6,87)	820,63	5,97%	17,69%	0,92%
2	500 - 1000	533	816,0 (126,0)	255,4 (319)	14,46 (6,65)	931,0	1,48%	19,59%	7,93%
3	1000 - 1500	1290	1290,7 (137,3)	382,4 (494,6)	18,70 (6,52)	988,9	0,21%	19,32%	24,88%
4	1500 - 2000	1747	1759,7 (145,1)	488,4 (1370,8)	22,91 (6,55)	1024,0	0,02%	19,12%	47,85%
5	2000 - 2500	1477	2248,1 (142,4)	566,8 (770,9)	27,86 (8,70)	1058,4	0,07%	22,34%	67,27%
6	2500 - 3000	1057	2725,3 (148,7)	765,6 (2095,5)	31,22 (8,16)	1111,9	0,01%	20,55%	81,16%
7	3000 - 3500	625	3233,8 (144,7)	667,4 (804,5)	33,18 (8,89)	1130,0	0,01%	30,39%	89,38%
8	3500 - 4000	335	3724,2 (143,2)	788,7 (1444)	36,39 (9,46)	1167,0	0,01%	31,80%	93,78%
9	4000 - 4500	171	4233,2 (140,3)	652,3 (916,9)	37,63 (9,72)	1132,0	0,01%	49,04%	96,03%
10	4500 - 5000	119	4774,3 (156,5)	843,8 (1892,5)	39,95 (9,29)	1164,0	0,00%	54,57%	97,59%
11	5000 - 5500	73	5175,0 (143,8)	969,9 (2585,3)	42,16 (8,72)	1229,0	0,00%	49,76%	98,55%
12	5500 - inf.	110	6691,3 (1701,0)	495,9 (986,9)	41,37 (15,82)	1260,0	0,45%	77,09%	100,00%

Source: Own calculation on the basis of SSSU data

Number of elements in in each group remains significant (at least 70), it gives backgrounds to confirm that calculations are representative. It was found that there is a relation at 0.01 level of significance between the spending per 1 hectare and increasing of arable lands size (defined after additional calculations). With the rising of costs per 1 ha average yields is increasing (correlation coefficient is 0.608 at the significance level 0.01) and average selling prices is increasing. Thus, after investing more money in each ha of production, the producer expect to have better harvest and sale his products at the higher price, which will ensure profit.

Every enterprise is planning to sell their products at the price that equals to the average price in each group i – $\overline{p}_i$. Then, income for j enterprise in i cost group, with crop yield y_{ij} is:

$$EI_{ij} = \overline{p}_i \cdot y_{ij} , \quad (1)$$

Expected income from 1 ha of wheat crops for i cost group:

$$EI_i = \overline{p}_i \cdot \overline{y}_i , \quad (2)$$

where $\overline{y}_i$ is expected yield for i cost group. Standard income deviation (when prices are fixed) is:

$$\sigma(EI_i) = \overline{p}_i \cdot \sigma(y_i) , \quad (3)$$

where $\sigma(y_i)$ is a standard yield deviation in group i.

Risk could be estimated as the probability to get zero income from 1 hectare (have a zero yield) – $PR(EI_{ij} < 0)$,or as the probability of getting income less than average costs (C_i) for 1 ha of crops – $PR(EI_{ij} < C_i)$. If income distribution law is normal:

$$PR(EI_{ij} < 0) = \Phi(x') , \quad (4)$$

$$PR(EI_{ij} < C_i) = \Phi(x'') , \quad (5)$$

where $\Phi(x)$ is Laplass function:

$$\Phi(x) = \frac{1}{\sqrt{2\pi}} \int_{-\infty}^{x} e^{-\frac{t^2}{2}} dt , \quad \Phi(-x) = 1 - \Phi(x) \quad (6)$$

where $$x' = \frac{0 - EI_i}{\sigma(y_i)} , \; x'' = \frac{C_i - EI_i}{\sigma(y_i)} \quad (7)$$

Calculated parameters of risks were recorded in the table 2. As we can see the risk of getting zero yield decreases monotonically and is almost below 1% for all types of businesses. Exceptions are the first two groups, where the costs per 1 ha do not exceed 1000 UAH (125 USD). Low cost level is the reason of high-level dependences from natural risks.

The risk to get income less than the cost of production (to get negative profit) increasing monotonically in accordance with exponential trend (coefficient of determination 0.946, table 2). It should be mentioned that in the first 6 groups where costs are less than 3000 UAH per 1 ha, the risk to get negative profit is less than 28%. Nevertheless, the agricultural sector found it as the highest permissible level of risk that was subconsciously chosen by most agricultural enterprises in 2010. 81.6% of companies (according to the distribution function) decided to spend less than 3000 USD per 1 ha of wheat in 2010. It means that exactly this part of agrarian business operates under the level of risk less than 28%.

Let us find the average risk of loss in wheat production for Ukraine in 2010. Average yields in Ukraine was $y_{ij} = 27.98$ (cwt/ha), standard deviation of crop yield was $\sigma(y_i) = 10.5$ (cwt/ha), average production cost for one ha was $C_i = 2490.5$ UAH, average selling price of 1 cwt of wheat was $\overline{p}_i = 108.8$ UAH [15]. When we had substituted the data into the formulas (7, 6), we obtained that the risk of revenue less then cost for 1 ha is $PR(EI_{ij} < C_i) = 31.39\%$. We assume that one yield concentration of production (monoculture) is too risky in Ukraine.

There is a correlation between the selling prices and production cost. It corresponds to the logarithmic tendency with a coefficient of determination 0.97. It is shown at the Fig. 2.

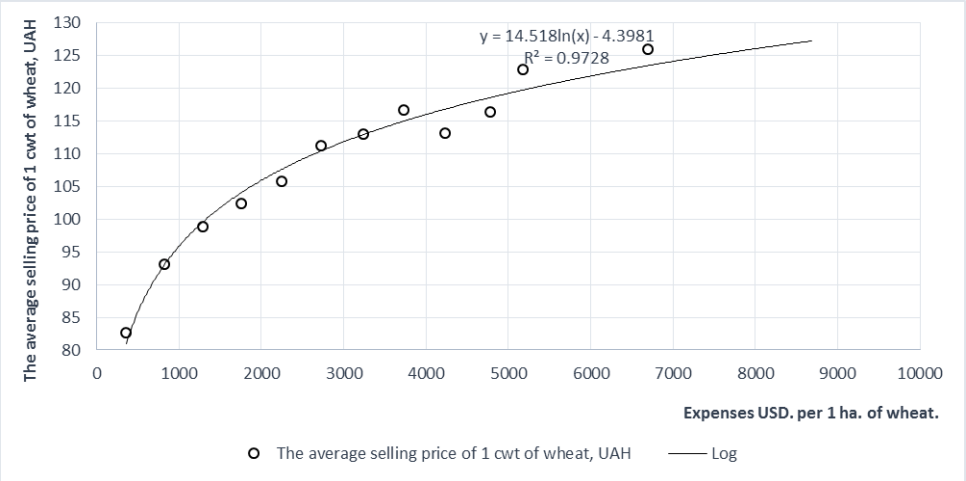

Figure 2. The prices dependence on production expenses per 1 ha

Financially powerful companies have direct access to the export of production, higher selling price and low price variability. It indicates that competition on the market is not perfect. The producers with the preferential right of entrance to the foreign market (direct export of their products) have significant

economic benefits against the small producers and can reach positive profitability even with high variability of prices on the Ukrainian market.

Let analyse the changes in losses risk of enterprise that produces more than one type of crop depends on the arable land size (from 1 to 7 crops, list of crops was shown above). We grouped the data by the arable land size with step 200 ha (200 ha for the first 20 groups and increasing step up to 7500 for another groups). We have 23 groups with the number of elements at least 75 companies. For risk assessment we use profitability of each group: $R_i = \frac{EI_i - C_i}{C_i} \cdot 100\%$, and standard deviation of profitability $\sigma(R_i)$ in i group (Normal distribution supposed) . The risk of negative profitability for different categories of enterprises is $P(R_i < 0) = \Phi(x''')$, where $x''' = \frac{R_i}{\sigma(R_i)}$. The risks and profitability calculations for each separate group are shown in Fig. 3.

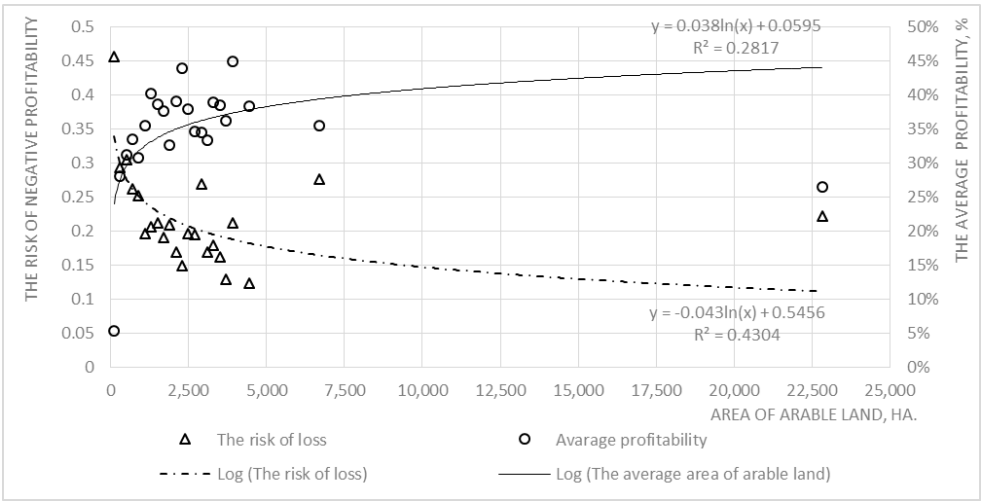

Figure 3. Average profitability and the risks of losses depend on the area of arable land (for 1 up to 7 crops).

The calculations clearly observed monotonic tendency of increasing profitability that depends on the size of arable lands and the risk decreasing. Logarithmic trend describes this dependence with coefficient of determination $R^2 = 0{,}43$, but model is significant at the 5% significance level according to the criteria of Pearson and Fisher ($P = 0{,}0007$ and $F = 15{,}87$). In addition, significant

are the coefficients of regression equation (at the 5% level). Thus, diversification of production by growing more than one crop significantly reduces the variance of return in each separate group and leads to the monotonically decreasing risk of losses (risk of negative profitability).

4. Conclusions

In the context of not completed agrarian reform and not existed land market in Ukraine, structural transformation of agricultural production has already been going for 21 years. After the collapse of the command-planned economy, lands redistribution had not led to the expected results – Ukraine had not become farming country. Rather the existence of three different forms of land-using (farms, householders and agrarian enterprises) creates the list of problems that negatively affected on Ukrainian rural development. Ukrainian village in the absolute number of indicators is significantly behind the city.

Currently the structural transformations of agricultural production are undergoing in Ukraine. Appears the tendency of production consolidation by the large farms and agricultural enterprises. The largest of them – "agro holdings" exacerbate the social problems of the village. Normally they use highly skilled staff from the city and increase unemployment level in rural [16]. It was revealed that the economic justification of the agricultural producers' consolidation (except increase in their efficiency) is the reducing of risks and increasing of expected sale price. Normally, the large enterprises have powerful financial support and direct access to the world food market, where prices have less variability than in the Ukrainian food market. It proves the inequality conditions on internal Ukrainian market for the different companies.

Besides the agricultural producer consolidation, a quarter of all companies produced from 1 to 7 crops in 2010 remained unprofitable. The analysis of loss and profits structure of enterprises that cultivates only one crop (wheat) showed that there is no trend of reducing of unprofitable enterprises number. Therefore, consolidation of production in the context of all companies does not lead to the rapid increase in the expected economic benefits and economic changes. In particular, specialization of production on one crop (wheat) and increasing of costs on it causes significant variability of profit. It leads to increasing of losses risk. For multi-crops production situation differs significantly. Profitability is increasing monotonically, and the risk of losses is decreasing monotonically.

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