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SECTION 16. QUANTITATIVE METHODS IN ECONOMICS

16.1 Econometric analysis of regional grain production In Ukraine

Cereals are wide spread and strongly demanded crops in the world. The Food and Agriculture Organization of the United Nations (FAO) determined the level of grain provision to be one of the basic indicators of food security. So far, Ukrainian farmers belong to Top 10 producers and exporters of cereals at the global scale. Overall, they harvested record yields in 2018. At present, the national agrarian sector is the most stable in Ukrainian economy. Its contribution to the total GDP increased from 7 % in 2007-2009 up to 12 % in 2015-2018 [406]. This achievement was largely created by the national grain producers. Given the natural climatic conditions, the major grain crops in Ukraine are wheat, barley, and maize.

Namely, Ukraine harvested 26209 thousand tons of wheat which was less than in China, India, Russia, the USA, France, Canada, Australia, and Pakistan. Meanwhile, Ukraine covered 7.3% of wheat export at $3 billion that corresponded to the sixth world rank after Russia, Canada, the USA, France, and Australia. The main importers of Ukrainian wheat were Spain and Italy in Europe, Indonesia and Bangladesh in Asia, as well as Egypt, Morocco, and Tunisia in Africa.

Ukrainian farmers gathered 8285 thousand tons of barley which was less than in Russia, Australia, Germany, and France. At the same time, Ukraine encompassed 8.9% of barley export at $0.68 billion that meant the fourth global rank after Australia, France, and Russia. The prime buyers of Ukrainian barley were Spain in Europe, Saudi Arabia and China in Asia, as well as Libya and Algeria in Africa.

Ukraine harvested 24669 thousand tons of maize which was less than in the USA, China, Brazil, Argentina, India, Indonesia, and Mexico. However, Ukraine occupied 10.3% of maize export that complied with the fourth world rank after the USA, Argentina, and Brazil. The core importers Ukrainian maize were the Netherlands, Spain, and Italy in Europe, China and Iran in Asia, as well as Egypt, Tunisia, and Libya in Africa.

Outputs of Ukrainian crop production in domestic and international markets accumulate results of 24 regions. High volatilities of the natural and market conditions suppose regular monitoring of dynamics and effectiveness of grain production since it influences the State budget, welfare of rural population, and competitiveness of Ukrainian agriculture. In particular, for the past decade the cereals profitability fluctuated from 1.5% to 43.1%. Simultaneously, the respective grain harvests varied from 39.3 to 70.1 million tons [406]. Thus, economists had to face the listed pressing issues and provide quantitative analysis of regional grain production. The relevant research was conducted by numerous scientists [407-411].

The most promising approach to improving agribusiness was connected with applying mathematical methods and information technologies [412, 413]. In particular, econometric methods maintained reliable solutions for agricultural problems based on diverse contemporary software [414]. It is worth mentioning that the most valuable outcomes focused on Ukrainian agrarian sector proposed not only econometric calculations but also gave detailed recommendations on improving productivity of the national agriculture [415, 416].

Nevertheless, there is still an open question concerning the quantitative evaluation of the regional grain production affecting further development of the cereals segment in Ukrainian agriculture. To tackle such issue this research was aimed at:

– defining econometric trends in total harvests, sown areas, and yields of cereals at the regional level;

– comparing dynamics of wheat, barley, and maize production relative to the national indicators;

– revealing changes in growing grain crops at the regional level.

The methodical framework of this study was formed by simple linear regressions or time series models [414]. With regard to task 1 it made possible to compute annual trends which described dynamics of grain production. Meanwhile, the corresponding coefficients of variation assessed stability of the found indicators. With regard to task 2 the selected approach determined a relative regional contribution to the national grain production and evaluated its stability via standard deviation. Finally, in the context of

task 3 the explored distribution of the sown areas under wheat, barley, and maize grounded contemporary trends over their regional harvests.

The identified technique is appropriate to each of 24 Ukrainian regions. All of them but with different shares participate in growing cereals. For example, this study dealt with the detailed econometric analysis of Dnipropetrovsk region. Given the volatile economic environment typical of Ukrainian farming, the statistical samples reduced to the period of 2014 to 2018. The research calculations were run through the tools of the spreadsheet LibreOffice Calc.

Thereby, Table 1 aggregated data on dynamics of grain production in Dnipropetrovsk region. It clarified an upward trend in the regional grain production with an annual average increase by 5.16 thousand tons. The bumper harvest of 3866.2 thousand tons was gathered in 2015. According to the computed coefficients of variation, such trend is more stable compared to the national progress. However, it was provided largely by maize which had an annual increment by 71.49 thousand tons and the bumper harvest of 1329.7 thousand tons in 2018. On the contrary, the average wheat harvest of 1691.84 thousand tons was less by 16% than the maximum of 1996.6 thousand tons in 2015. Wheat and barley had also alarming drops in their harvests by 43.87 thousand tons and 24.75 thousand tons per annum. Besides, the current average barley harvest of 650 thousand tons equaled only 68.4% of the record 951.5 thousand tons in 2006.

In general, annual shrinks of sown areas under cereals by 13.9 thousand ha were the promising signals (see Table 1). Really, Ukraine belongs to the Top 5 countries by the share of cultivated areas. That is why such land conservation will contribute to restoring soil fertility. The higher coefficient of variance concerning sown areas of wheat and maize in Dnipropetrivsk region meant more optimal crop turnover compared to the state level.

Table 1.

Absolute dynamics of regional grain production

Indicators	Average value	Annual trend	Coefficient of variance, %	
			region	state
Production, thousand tons				
cereals	3546.14	5.16	5.70	5.99
wheat	1691.84	-43.87	11.93	4.17
barley	650.96	-24.75	10.07	9.48
maize	1120.34	71.49	13.73	17.27
Sown area, thousand ha				
cereals	1135.94	-13.9	3.23	1.14
wheat	502.04	-2.83	11.26	5.14
barley	269.80	-7.67	5.32	8.38
maize	322.80	-5.35	6.54	5.17
Yield, centners per ha				
cereals	31.24	0.41	4.85	5.84
wheat	33.76	-0.66	6.58	4.74
barley	24.14	-0.26	8.82	5.90
maize	34.94	2.71	17.42	14.56

The world experience convinced that agriculture should reduce utilization of the natural resources but paired with the increasing productivity. Table 1 reported that regional yields of cereals raised by 0.41 centners per ha per annum. Such progress was more stable by 1 percentage point with regard to the national level. Unfortunately, the average yield of 31.24 centners per ha was less than the maximum 35,2 centners per ha in 2001. Like for the total production, the mentioned output was provided by maize with an annual yield increment by 2.71 centners per ha and the record 43 centners per ha in 2018. On the contrary, unfavorable climate conditions and violation of the agrarian technologies caused the negative trend of decreasing regional yields of wheat and barley by 0.66 centners per ha and 0.26 centners per ha, respectively. It resulted in poor wheat yield of 30 centners per ha in 2018 that was less by 30.2% than the exemplary 43 centners per ha in 2001. Similarly, barley yield dropped to 21 centners per ha that was less by 31.6 % compared to the exemplary 30.7 centners per ha in 2001.

Table 2 contained the calculated results to task 2. It revealed a stable contribution of the region in question to the state production of barley and maize with the relative shares of 7.68% and 4.04%. Wheat growing appeared to be less optimistic. Really, its regional contribution shrank by 0.19 percentage point per annum and was the most unstable among the other grain crops.

Table 2.

Relative dynamics of regional grain production

Indicators	Average value, %	Annual trend, p.p.	Standard deviation, p.p.
Share of production			
wheat	6.63	-0.19	0.68
barley	7.68	0.003	0.42
maize	4.04	0.03	0.58
Share of sown area			
wheat	7.83	-0.13	0.59
barley	9.90	0.21	0.35
maize	7.34	-0.16	0.45
Share of yield			
wheat	84.63	-1.03	3.24
barley	77.70	-1.6	4.91
maize	55.16	1.54	8.16

The regional shares of areas under wheat and maize decreased by 0.13 percentage point and 0.16 percentage point per annum and equaled on average 7.83% and 7.34%. By contrast, the shares of regional areas under barley raised by 0.21 percentage point per annum up to 10.3% in 2018. It implied that other Ukrainian regions gradually diminished this crop but Dnipropetrovsk farmers filled the emerging gap in the national husbandry.

The study of relative yields of wheat and barley resulted in a disappointing conclusion on increasing backlog of the regional productivity by 1.03 percentage point and 1.6 percentage point. So far, the yields of wheat and barley in Dnipropetrovsk region appeared to be less than the national level by 19.6% and 29.1%. Simultaneously, maize

yield amounted to 55.2% compared to the average in Ukraine. However, there was an upward trend by 1.54 percentage point per annum to bring the regional maize yield closer to the national indicator.

Table 3 combined calculations referred to task 3. The analyzed data showed the essential regional prevalence of wheat among the other cereals with an annual rise by 0.31 percentage point. It was associated with shrinking areas under barley and maize. Meanwhile, the rest of cereals occupied only 3.65% of the cultivated area in Dnipropetrovsk region.

Table 3.

Dynamics of specialization of regional grain production

Shares of sown area under cereals	Average value, %	Annual trend, p.p.	Standard deviation, p.p.
Wheat	44,13	0,31	3,84
Barley	23,77	-0,39	1,40
Maize	28,46	-0,13	2,35

Official statistics for 2018 informed that Dnipropetrovsk region occupied fifth, third and eleventh ranks among the regional producers of wheat, barley and maize. For 2017 they ranked fourth, third and tenth, as well as fifth, third та ninth in 2016 [406]. The performed monitoring over the regional production of cereals revealed an urgent need for enhancing effectiveness of farming. Its avenues can be specified as follows.

Firstly, the share of grain production by agricultural enterprises of Dnipropetrovsk region reached 63.2% which was less by 16.9 percentage point than the average indicator at the national level. Similar indicators of Top 4 cereals producers such as Vinnytsya, Odessa, Poltava, and Kharkiv regions were 85%, 71.8%, 83.6%, and 70.8% [406]. Thus, the farmers of Dnipropetrovsk region should focus on integration and cooperation to boost effectiveness of growing cereals.

Secondly, the technical provision of farmers in Dnipropetrovsk region was far from satisfying. In particular, there were 36 grain and 10 combine harvesters per 10000 ha of the cultivated area by 2018. These indicators ranked sixteenth and eighth among

Ukrainian regions [406]. Therefore, the relevant machinery upgrading would have a positive impact on enhancing the regional grain production via cutting loss of the cereals harvest.

Thirdly, application of chemical fertilizers under cereals in Dnipropetrovsk region was 84 kg per ha for 2018. It ranked twentieth around the country and was less by 26 kg than the average national indicator [406]. Thus, to offset the insufficient precipitation farmers of Dnipropetrovsk region should optimize drought management and apply more nitrate and phosphate fertilizers under grain crops.

Overall, the proposed technique of econometric analysis over dynamics and stability of regional cereals production would provide the justified quantitative reference points of

– microeconomic development of growing wheat, barley, and maize at the expense of implementing innovative technologies;

– macroeconomic progress in the grain segment of Ukrainian agriculture and the global food security system by means of raising its structural part in the world production and export.

The further monitoring of the regional grain production using mathematical methods and information technologies will be beneficial for strategic support of Ukrainian farmers.