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RISK ASSESSMENT OF SHOCK PERIODS AND INVESTMENT ATTRACTIVENESS OF AGROHOLDINGS OF UKRAINE

Purpose. *This paper deals with analysis and assessment of the risks specific to the agricultural business under conditions of macroeconomic uncertainty associated with the war unleashed by russia on the territory of Ukraine. The performed study included the stability analysis of the agricultural holdings in Ukraine before and after the shock period, and their investment attractiveness.*

Methodology / approach. *In the research process, a combination of methods of risk analysis of Ukrainian agricultural holdings during the shock period and the speed of recovery of their investment attractiveness was proposed. Daily stock rates of selected agricultural holdings served as information support for calculations. The sample was subdivided into three periods: before the shock, which was characterized by a certain level of stability; the shock period caused by the war; and the recovery period after the shock. The study was carried out with the use of the shock depth indication and the recovery level following the shock, the risk analysis based on VaR and CVaR approach and forecasting of further liquidity curve of the agricultural producers based on Holt-Winters' model.*

Results. *The depth of the fall in the shock period (Sd) and the level of recovery after the shock period (Rl) for agricultural holdings of Ukraine have been established. The Sd indicator ranged from -44 % to 71 %, and Rl averaged 56 %, which confirmed the insignificant level of recovery of capitalization of agricultural holdings. Positive trends of overcoming the shock period were established for all studied agricultural holdings of Ukraine. A significant difference in the liquidity of assets of agricultural holdings was revealed.*

Originality / scientific novelty. *The originality of the research is the approbation of a set of methods that allow simultaneously considering various features of the manifestation of risks caused by russian full-scale armed aggression.*

Practical value / implications. *The practical value of the research lies in the determination of the negative impact of the risks of shock periods and the assessment of the investment attractiveness of agricultural holdings, which can be used for decision-making. The proposed approaches can be recommended for the analysis of other agricultural enterprises and for potential investors in other periods of significant changes and in the post-war period.*

Key words: *agricultural business, macroeconomic instability, risk, shock period, war.*

Introduction and review of literature. The importance of studying how the agribusiness is run under conditions of macroeconomic uncertainty is confirmed by the fact that Ukraine possesses a great agro-industrial potential and has striking prospects to develop its agriculture wherein the agrarian sector plays one of the predominant and most significant roles in ensuring welfare, security and independence by earning up to 20 % of the gross domestic product (GDP).

Favourable climate, fertile lands and long-standing agricultural traditions facilitate its further development and harvesting agricultural crops to the extent sufficient to guarantee food security of the state and formation of the export potential.

Before the russia's military invasion, Ukraine was among the world leaders in the export of agricultural products, thereby ensuring the food security of many countries (Voronenko et al., 2020; Starychenko et al., 2020; Dibrova et al., 2022; Mohylnyi et al., 2022; Skrypnyk et al., 2021). Annually Ukraine produced about 100 million tons of grain, leguminous and oil crops, which made it one of the biggest world exporters.

Yet the russian aggression and invasion of Ukraine created new challenges and risks for the agricultural sector. Just for the first three months of the war the total loss of the agrarian sector comprised more than USD 4.4 billion, which accounts, approximately, 15 % of its capital stock. Due to rapid inflation, decrease of production, rise of prices of production and blockade of the ports, the indirect losses of the agricultural branch reached USD 23.3 billion (KSE, 2022; MAPFU, 2022). The outbreak of war caused a shock in the global grain and oilseeds market, prices increased significantly and supply volumes fell. In March, FAO informed that the global food price index in February reached its historic maximum after the steady growth during the preceding years (FAO, 2022). The experts also calculated that the number of people suffering from hunger in the entire world might reach the 15th year maximum as a result of the war, COVID-19 and negative impact of the climate change (Barrett et al., 2021; Osendarp et al., 2022).

Regarding the macroeconomic uncertainty, the war with the RF makes the main problem. Russian invasion in Ukraine led to humanitarian catastrophe, disturbed the country-wide power grids and the global agricultural product markets. Therefore, now a transition to healthy, equitable and ecologically sustainable food procurement system is being substantiated and the key initiatives for the global politicians are being outlined so as to minimize the shocks of offers and prices and improve resistance of the food systems to future crises (Pörtner et al., 2022; Banse, 2022).

Other scientists compare the 2022 war with the financial crisis of 2009 and COVID-19 pandemic as there is exponential growth of uncertainty which negatively influences consumption and investments, produces a depressive impact upon the GDP and employment: the longer the war lasts, the greater and more persistent its consequences will be (Bentley, 2022; Celi et al., 2022; Zavidna et al., 2022; Nikolaeva et al., 2022). The russian war in Ukraine is a problem for many countries. Foreign scientists emphasize that the food crisis will become harder if the war continues (Glauben et al., 2022; Hassen & Bilal, 2022; Fiott, 2022) and puts forward challenges for many countries, particularly those that depend on food imports, such as the Near East and Northern Africa countries (Câmpeanu, 2022). Also, russian aggression exacerbated negative trends in global food markets, as food prices were already high due to supply chain disruptions caused by the COVID-19 pandemic, high world demand and poor harvest in some countries (FAO, 2020; Kaminskyi et al., 2020).

Accordingly, certain studies deal with the investigation of the direct and indirect impact of the russian-Ukrainian war on the global food security. It is emphasized that

this war has led to instant and long-term cascade consequences in the global food security (Hassen & Bilal, 2022; Simchi-Levi & Haren, 2022).

An important issue is the speed of recovery of agribusiness in Ukraine. This speed is determined by the ability to adapt to crises, liquidity and investment attractiveness. For this, it is necessary to analyze the ability to recover from crises. Existing research in this area (Szegö, 2004; Vinichenko et al., 2021; Paul, 2020; Racicot & Théoret, 2016) is related to the study of recovery after crises. However, this crisis is unprecedented because it is not only financial in nature.

Therefore, the analysis of the possibilities of recovery of agroholdings after a shock period, the assessment of their investment potential and attractiveness, as well as the forecasting of their development trends in the conditions of the existing macroeconomic uncertainty are of research interest and are valuable for practical application. Our article is dedicated to this.

The purpose of the article. This paper deals with analysis and assessment of the risks specific to the agricultural business under conditions of macroeconomic uncertainty associated with the war unleashed by russia on the territory of Ukraine. The performed study included the stability analysis of the agricultural holdings in Ukraine before and after the shock period, and their investment attractiveness.

Results and discussion. The share of the agricultural sector in the structure of the gross domestic product in 2021 was one of the most significant among all sectors of the country's economy and reached 10.6 %. Such situation was possible due to a considerable gain of production which equaled 14.4 %. The curve reflecting the growth of this indicator is shown in Figure 1.

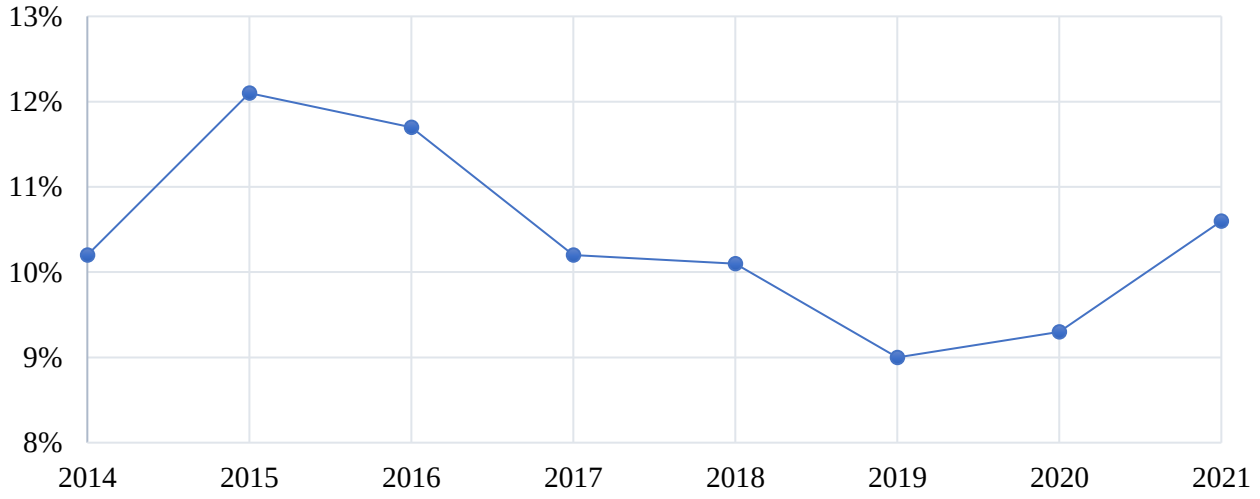

Figure 1. The share of the agricultural sector in the structure of the GDP of Ukraine, %

Source: the authors' computations based on (SSC, 2022).

The producers of agri-food sector are usually divided into two groups: households and agricultural enterprises. The first group includes more than 4 million households, which on average cultivate 1.2 ha of land and produce almost 45 % of the gross agricultural output. The second group comprises more than 45,000 enterprises that account for 55 % of the gross output (UCAB, 2023).

In order to assess the risks for Ukrainian agrarian producers under current macroeconomic uncertainty and, in particular, in the shock period, the largest agricultural holdings of Ukraine listed on the London Stock Exchange (LSE) were selected, namely: MHP company (MHP), Astarta (ASTH), Agroton (AGTP), IMC company (IMC), Ovostar (OVO), Agroliga (AGLP), KSGAgroo (KSG) and Kernel (KER). Research was carried out using the programming language R and software environment R-Studio for statistical calculations and analysis – package ("quantmod"), package ("Performance Analytics"), package ("xlsx"), package ("tidyverse"), package ("gridExtra").

The database of the study included daily prices of the selected agricultural holding stocks (Figure 2). This data was taken from the Internet resource Investing.com. Afterwards the sample was divided into three periods: the first one (01.08.2021 – 23.02.2022 –marked in red on the graph) was the period prior to the shock which is characterized by a certain level of stability; the second period (24.02.2022 – 24.05.2022 marked in blue on the graph) corresponded to the shock (sowing season) caused by the war; and the third period (25.05.2022 – 31.10.2022 marked in green on the graph) reflects the period of recovery after the shock.

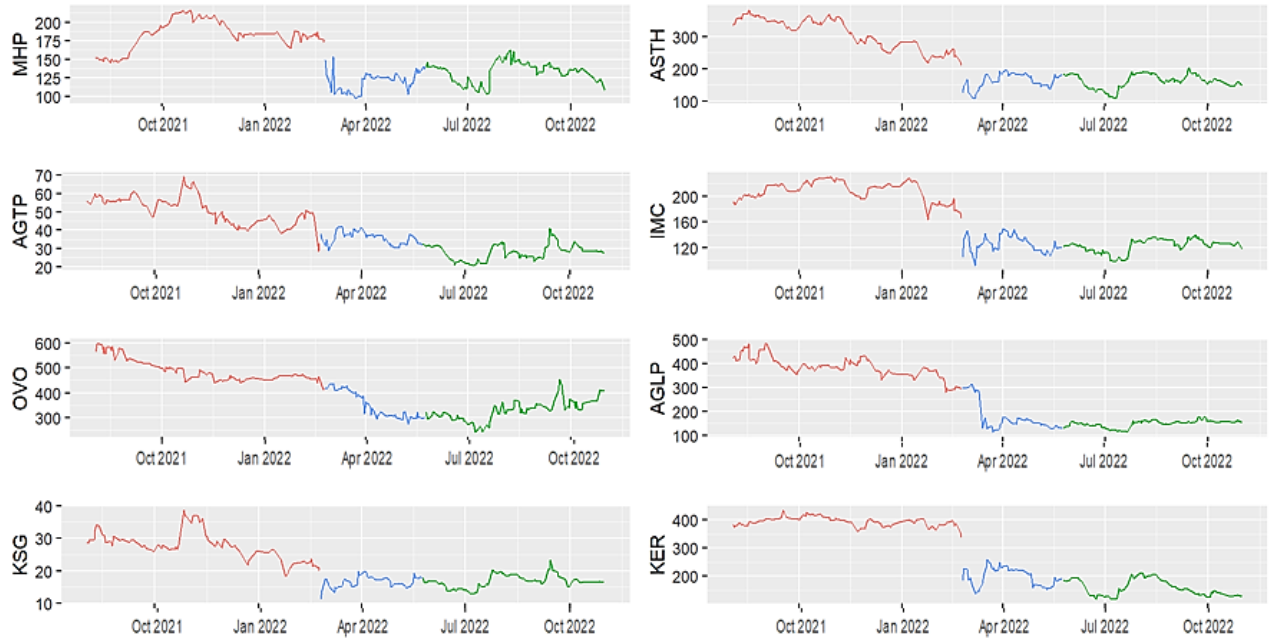

Figure 2. Dynamics of share prices of agricultural holdings of Ukraine on the London Stock Exchange, UAH

Source: the authors' computations based on Investing.com.

The basis of modern risk measurement are the basic concepts of financial risk assessment: the concept of measuring financial risks within the framework of the theory of expected utility; concept of variability; the concept of losses in adverse situations (shocks) (Szegö, 2004; Paul, 2020; Kaminskyi, et al., 2020; Racicot & Théoret, 2016). Not all of these methods can well assess the risks of shock periods, which are characterized by a large decline in indicators. The logic of the study, which includes the calculation and analysis of indicators of selected approaches to risk assessment and the possibility of recovery after shocks, is presented in Figure 3.

Figure 3. Research methodology

Source: built by the authors.

The use of classical risk measures for shock periods is incorrect due to the sharp drop in a short period. For risk analysis in shock conditions, two indicators were proposed, which, unlike classical risk metrics, make it possible to study shock periods. Such analysis was performed with the use of risk levels and variational approach. The risk–shock depth was the first indicator, which reflected the maximum negative profitability at the average price in the first period. The second indicator – the recovery coefficient – was determined as the average price for the third interval and was divided by the average price in the first period. The first indicator means, "shock depth" (Sd), which is determined as:

$$Shock\ depth = \frac{cost_{Sp}^{min}}{cost_{\bar{Sp-1}}} - 1, \quad (1)$$

where $cost_{Sp}^{min}$ – means the minimum price in the shock period;

$cost_{\bar{Sp-1}}$ – means the average price in the before-shock period.

The second indictor reflects "recovery level" (*Rl*), which is determined as:

$$Recovery\ level = \frac{cost_{\bar{Sp+1}}}{cost_{\bar{Sp-1}}} * 100, \quad (2)$$

where $cost_{\bar{Sp+1}}$ – means the average price in the after-shock period.

Part of the comparative analysis in different periods includes changes in the values of indicators reflecting the variability of profitability. A comparative analysis of fluctuations in the value of shares of agricultural holdings for three periods was carried

out (Table 1).

Table 1

Indicators of risk analysis of agroholdings of Ukraine during shock periods

Period	MHP	ASTH	AGTP	IMC	OVO	AGLP	KSG	KER
Average price in the after-shock period, UAH	133.28	162.93	27.95	122.85	327.92	148.35	16.87	158.66
Minimum price in the shock period, UAH	96.54	107.40	28.89	91.93	274.71	113.41	11.31	137.16
Average price in the before-shock period, UAH	182.54	313.23	51.55	206.35	493.13	385.42	27.88	392.61
Shock depth, %	-47	-66	-44	-55	-44	-71	-59	-65
Recovery level, %	73	52	54	60	66	38	60	40

Source: calculated by the authors.

The first indicator can be interpreted as "degree of risk" and the second one as "profitability level" (meaning the non-classic profitability). Sd has a classic profitability nature with a certain specificity connected to the average price in the before-shock period. This procedure excludes the price volatility prior to fall in prices. Rr takes into account the ratio of the appropriate after-shock prices to the prices before the shock. The logic behind the use of Rl is to compare the assessment with the before-shock period and not with the minimum price in the second period.

Application of the indicators "shock depth" and "recovery level" makes it possible to visualize the picture in the two-dimensional space for each agricultural holding (Figure 4).

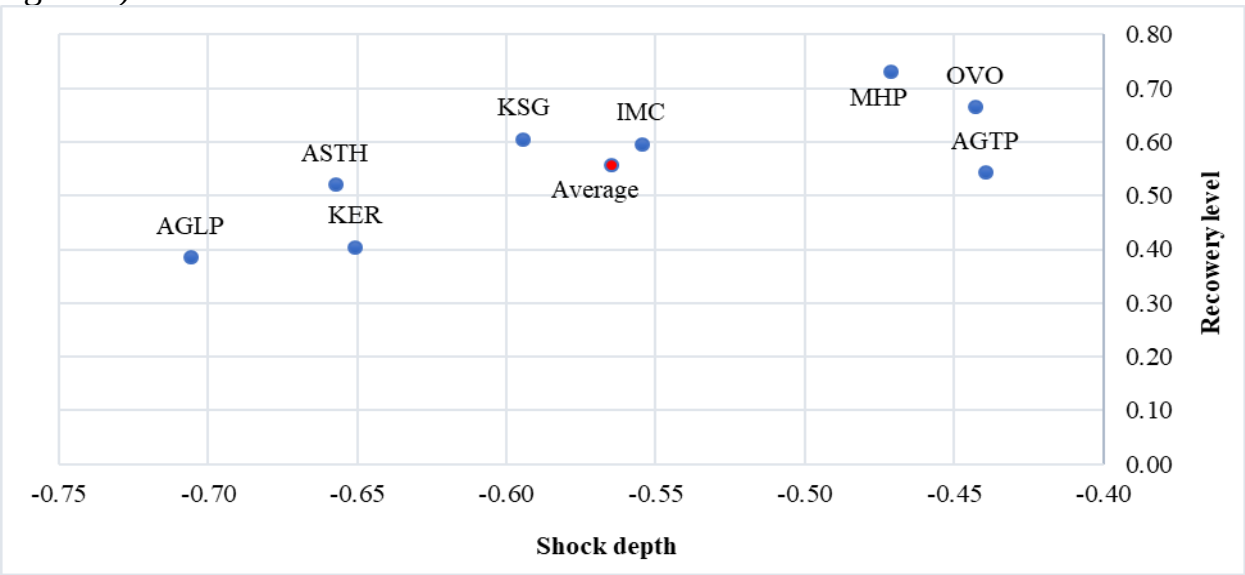

Figure 4. The depth of the shock and the level of recovery of assets of agricultural holdings of Ukraine in the studied periods

Source: calculated and built by the authors.

The first indicator is the depth of the fall. In the context of our work, this can be interpreted as "an assessment of risk in shock conditions". The second indicator is the percentage of recovery after a fall, this is interpreted as "return in shock". The economic meaning of this parameter can be interpreted in two ways. First, this is a formal interpretation of the situation for buying assets at the point of decline and

receiving income in recovery process. The second direction concerns the comparison of the level of recession and the level of recovery.

It is obvious that agroholdings reacted differently to the war shock. Ovostar (OVO) and Agroton (AGTP) turned to be less vulnerable to the shock which follows from their lower level of the shock depth. Much more difficult it was for the agricultural companies Agroliga (AGLP) and Kernel (KER) which demonstrated more directly the trend "deeper fall" in accordance with their lower "recovery level". On the average, the indicator Sd and Rl equaled 56 %, i.e. during 5 months of the after-shock period the companies recovered to just a half of the pre-war situation.

But the measurement of risk for another concept is based on the assessment of profitability (Artzner et al.,1999; Szegö, 2004). The return R of investment asset (in this document, shares of agricultural holdings of Ukraine on the LSE) during the time period [*t*; *t*+1] will be expressed through the formula:

$$R_{t,t+1} = \frac{(P_{t+1} - P_t)}{P_t}, \quad (3)$$

where P_t – prices of shares of agricultural holdings on the LSE, UAH at times *t* and *t*+1 correspondingly.

In this research the profitability evaluation was applied in respect of daily returns in the arithmetical form. Special attention was paid to evaluate the risks in the shock period.

The variable approach is based on assessing the variability of return (volatility). This approach dates back to the works by Markowitz and is the basis of models of modern portfolio theory (Markowitz, 1952; Markowitz, 1959). The application of a variable approach to risk assessment of agricultural holdings in accordance with the developed algorithm (Figure 3) makes it possible to reveal the specifics of behavior in different periods. The results of statistical analysis of shares, which includes: minimum and maximum value *R*, average value, standard deviation, skewness and kurtosis, are shown in the Table 2.

All agricultural holdings, except "MHP" and "Kernel", show positive profitability in the after-shock period. As regards the shock period, then, despite the war, the half of the companies had positive profitability. Still, the agrarians managed to perform the seed campaign successfully and the greatest Ukrainian agricultural holdings did not suffer considerable losses in the stock market.

As regards standard deviation, then the highest value is observed in the shock period which doubles the before-shock value. The ratio between the after-shock and before-shock periods is 132 %. The main reasons for the increase in risk were the high level of inflation and huge losses of companies since the beginning of the war. The Kernel company lost more than 100 million dollars in the field of oilseed processing. MHP suffered colossal losses in the poultry industry, due to which it was forced to reduce production capacity to 85 %. Astarta company lost almost 28 % of its net profit due to the temporary occupation of 4,000 hectares of land in the Chernihiv region (Petrushko, 2022). Analyzing the calculations, negative skewness indicates a long left tail of the distribution, or the possibility of greater losses than gains. Positive

asymmetry is a desirable characteristic for risk-averse investors.

Table 2

Indicators of a variable approach to assessing the risks of agroholdings

Company	Minimum value			Maximum value			Average value		
	Before the shock	The shock period	Period after the shock	Before the shock	The shock period	Period after the shock	Before the shock	The shock period	Period after the shock
MHP	-0.074	-0.335	-0.124	0.103	0.461	0.274	0.002	0.001	-0.001
ASTH	-0.168	-0.392	-0.120	0.092	0.214	0.240	-0.004	0.002	0.000
AGTP	-0.400	-0.173	-0.266	0.261	0.156	0.302	-0.003	0.001	0.001
IMC	-0.173	-0.368	-0.099	0.100	0.280	0.318	-0.001	-0.001	0.001
OVO	-0.112	-0.185	-0.243	0.064	0.145	0.218	-0.003	-0.004	0.005
AGLP	-0.154	-0.524	-0.095	0.127	0.207	0.291	-0.003	-0.008	0.003
KSG	-0.219	-0.438	-0.081	0.380	0.257	0.291	-0.002	0.003	0.001
KER	-0.087	-0.457	-0.110	0.060	0.240	0.251	-0.001	-0.004	-0.003
Average value for all agroholdings	-0.173	-0.359	-0.142	0.148	0.245	0.273	-0.002	-0.001	0.001
Change over periods, %	-	-	82	-	-	184	-	-	-43
Company	Standard deviation			Skewness			Kurtosis		
	Before the shock	The shock period	Period after the shock	Before the shock	The shock period	Period after the shock	Before the shock	The shock period	Period after the shock
MHP	0.029	0.101	0.052	0.296	1.233	1.587	1.570	9.071	8.094
ASTH	0.039	0.090	0.054	-0.824	-1.237	1.530	2.701	6.398	5.560
AGTP	0.068	0.060	0.072	-1.444	0.069	1.186	12.926	0.793	6.582
IMC	0.033	0.093	0.043	-1.689	-0.325	4.018	8.967	5.116	30.250
OVO	0.029	0.053	0.062	-0.637	-0.476	-0.071	2.210	2.980	3.342
AGLP	0.047	0.097	0.049	-0.226	-2.360	2.120	1.836	13.390	11.402
KSG	0.063	0.095	0.053	1.810	-0.765	2.741	13.946	8.929	11.413
KER	0.024	0.098	0.053	-1.056	-1.468	1.819	2.994	7.693	6.565
Average value for all agroholdings	0.042	0.086	0.055	-0.471	-0.666	1.866	5.894	6.796	10.401
Change over periods, %	-	-	132	-	-	-396	-	-	176

Source: calculated by the authors.

Figure 5 illustrates the risk-return relationship based on the classic Markowitz approach. For different agricultural enterprises, different increases in risk and profitability can be traced.

The Value at Risk approach is used, as a rule, to assess risks during periods of significant change (Rockafellar and Uryasev, 2000; Kaminskyi & Nehrey, 2019). VaR and CVaR approaches were also used to analyze the shock risks of agricultural holdings using a set of selected methods (see Figure 3). The Value at risk (VaR), i.e.,

the risk value means the statistics which quantitatively defines the level of possible financial losses of the firm, in the portfolio or standing for a certain time period. VaR evaluates the amount of potential losses, probability of the loss amount occurrence and the time period (Artzner et al., 1999).

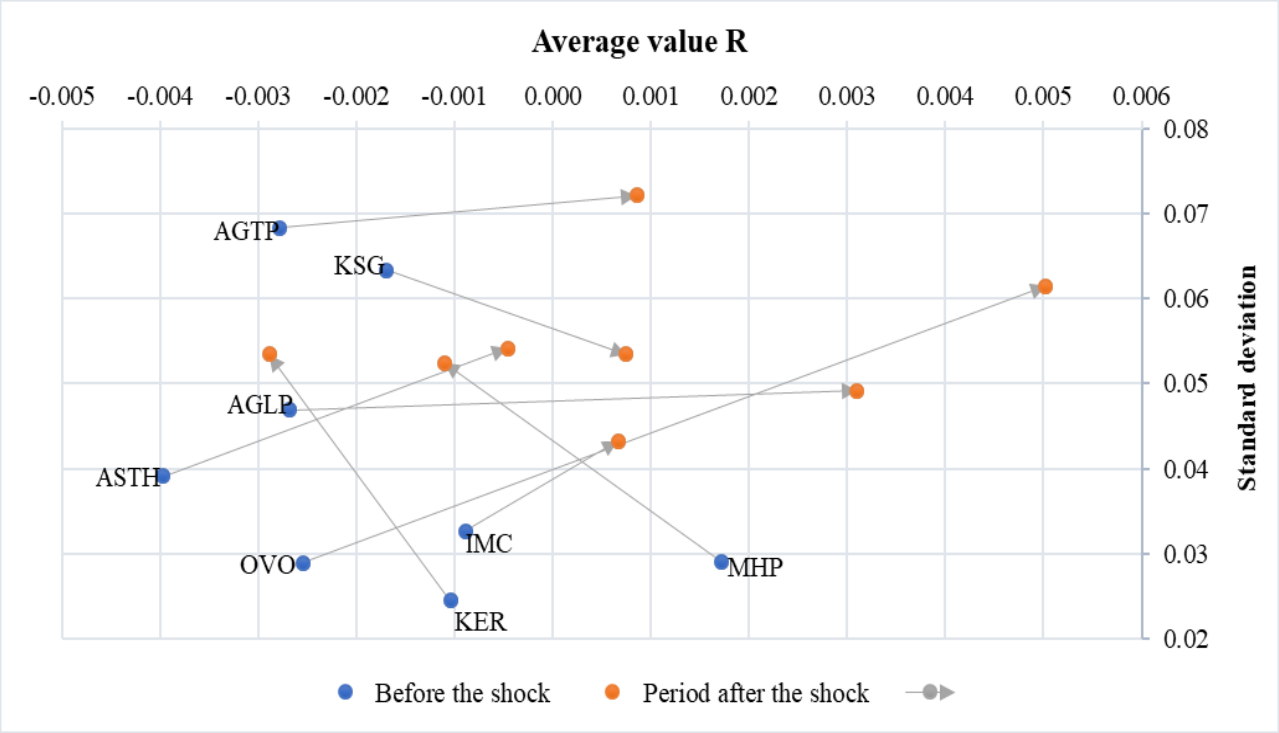

Figure 5. Changes in the risk-return ratio in the before-shock and after-shock periods of Ukrainian agricultural holdings

Source: calculated and built by the authors.

There is also a concept of Conditional value at risk (CVaR), i.e., an arbitrary value of risk, which is a measure of the risk appraisal which quantitatively determines the amount of the tail risk. CVaR is calculated by counting the average weighted value of "extreme" costs in the tail of possible income distribution beyond the point where VaR indicator is cut off. It is worth mentioning that a choice between VaR and CVaR is not always ambiguous, however, the majority of scientists (Sarykalin et al., 2014). tend to think that application of the CVaR, as a rule, to the more conservative approach from the risk viewpoint. There are three basic approaches to VaR calculation: a historical approach, parametric approach and simulation approach (Finance Train, 2010). The paper proposes three approaches for comparing the proposed methods VaR and CVaR. Table 3 shows the results computed according to the historical method.

Evidently, the worst indicators refer to the shock period. The VaR change equals 117 %, however, the CVaR change equals 90 % only, that is, before the war there were quite higher investment risks of investing in the proposed agricultural holdings than now. To choose the best indicator, the CVaR to VaR ratio was analyzed.

The change equals 77 %, which confirms the previous conclusions. According to the results of the variance-covariance method (Table 4) it is worth put forward the IMC and KSG agricultural holdings: the CVaR to VaR ratio equals 861 % and 1.034 % respectively, i.e., when using CVaR the investment risk will be 8 times higher. The

average change suggests that either the agricultural companies recovered strongly or difficult time began even before the war.

Table 3

VaR and CVaR indicators of the approach to measuring the risks of agroholdings using the historical method

Company	VaR			CVaR			CVaR/VaR, %		
	Before the shock	The shock period	Period after the shock	Before the shock	The shock period	Period after the shock	Before the shock	The shock period	Period after the shock
MHP	-0.045	-0.136	-0.079	-0.061	-0.219	-0.102	134	160	129
ASTH	-0.062	-0.090	-0.070	-0.104	-0.244	-0.092	168	270	131
AGTP	-0.080	-0.073	-0.091	-0.181	-0.126	-0.130	227	174	144
IMC	-0.043	-0.112	-0.043	-0.095	-0.245	-0.073	222	219	168
OVO	-0.049	-0.087	-0.076	-0.077	-0.145	-0.135	157	166	179
AGLP	-0.073	-0.127	-0.059	-0.120	-0.288	-0.075	164	227	127
KSG	-0.078	-0.079	-0.061	-0.139	-0.217	-0.071	179	275	116
KER	-0.038	-0.168	-0.068	-0.073	-0.274	-0.088	193	163	130
Average value for all agroholdings	-0.06	-0.11	-0.07	-0.11	-0.22	-0.10	182	202	140
Change over periods, %	-	-	117	-	-	90	-	-	77

Source: calculated by the authors.

Table 4

VaR and CVaR indicators of the approach to measuring the risks of agroholdings using the parametric method

Company	VaR			CVaR			CVaR/VaR, %		
	Before the shock	The shock period	Period after the shock	Before the shock	The shock period	Period after the shock	Before the shock	The shock period	Period after the shock
MHP	-0.043	-0.110	-0.053	-0.055	-0.110	-0.061	130	100	115
ASTH	-0.075	-0.163	-0.058	-0.117	-0.327	-0.088	157	201	151
AGTP	-0.123	-0.094	-0.083	-0.326	-0.123	-0.083	266	131	100
IMC	-0.063	-0.152	-0.016	-0.140	-0.263	-0.136	224	173	861
OVO	-0.054	-0.095	-0.093	-0.082	-0.151	-0.145	152	159	155
AGLP	-0.081	-0.196	-0.034	-0.117	-0.472	-0.104	145	240	309
KSG	-0.053	-0.155	-0.027	-0.053	-0.340	-0.281	100	219	1034
KER	-0.046	-0.185	-0.053	-0.073	-0.388	-0.120	158	209	224
Average value for all agroholdings	-0.07	-0.14	-0.05	-0.12	-0.27	-0.13	180	189	244
Change over periods, %	-	-	78	-	-	106	-	-	136

Source: calculated by the authors.

Table 5 demonstrates the results according to Monte Carlo method. This approach gives results that are more balanced: the VaR change is 128 % and the CVaR change

is 129 %. This is the only method where the investment risk for both indicators is greater after the shock. The choice between these two methods VaR and CVaR is not always obvious. But the analysis of significant fluctuations in indicators from CVaR is more perfect as a test of the assumptions imposed by VaR. Only the estimation based on the Monte Carlo method showed a ratio CVaR/VaR close to 100 %. High Var and CVaR indicators confirm a significant drop in the investment attractiveness of agricultural holdings in the post-shock period.

Table 5

VaR and CVaR indicators of the approach to measuring the risks of agroholdings using the simulation (Monte Carlo) method

Company	VaR			CVaR			CVaR/VaR, %		
	Before the shock	The shock period	Period after the shock	Before the shock	The shock period	Period after the shock	Before the shock	The shock period	Period after the shock
MHP	-0.046	-0.163	-0.087	-0.058	-0.205	-0.109	126	126	125
ASTH	-0.068	-0.145	-0.089	-0.084	-0.182	-0.112	124	126	125
AGTP	-0.115	-0.096	-0.117	-0.143	-0.121	-0.147	125	126	126
IMC	-0.054	-0.152	-0.070	-0.068	-0.191	-0.088	125	125	126
OVO	-0.050	-0.091	-0.096	-0.062	-0.113	-0.121	124	124	127
AGLP	-0.079	-0.167	-0.077	-0.099	-0.207	-0.098	125	124	126
KSG	-0.105	-0.152	-0.087	-0.132	-0.191	-0.109	125	126	126
KER	-0.041	-0.163	-0.090	-0.051	-0.204	-0.113	125	125	125
Average value for all agroholdings	-0.07	-0.14	-0.09	-0.09	-0.18	-0.11	125	125	126
Change over periods, %	-	-	128	-	-	129	-	-	101

Source: calculated by the authors.

Liquidity (trade volume indicator) can be viewed as an additional parameter that helps in risk assessment. The term “liquidity” refers to any asset that can be bought or sold. In a broad sense, liquidity is the property of an asset to be bought or sold quickly at a price close to its market value. A correct understanding of the concept of liquidity can help to choose assets that are more promising from the point of view of potential profitability.

The main logic for use of the liquidity concept can be explained by, at least, three factors. The first factor focuses on a possible problem of low liquidity. As the liquidity demonstrates a very low level, it can materially affect the price and, accordingly, the profit. Each big trade will influence the profit on assets. So, in this situation it can be incorrect to apply the market risk measurement because it is distorted. The second factor reflects the interdependence between the risk-profit and the liquidity change ratio. When the risk increases and the growth returns, the investors will restructure their portfolios, which increases liquidity. The third factor is related to the portfolio restructure during the shock period. There is a high probability that the third factor will prevail – investors will begin to restructure their portfolios more intensively because of the war.

Assessing the liquidity of agricultural holdings' assets and the ability to recover after a shock period is the next step of the analysis (see Figure 3). Therefore, the average daily trading volume of assets of agricultural holdings on the London Stock Exchange was analyzed. The liquidity of assets is considered using such an indicator as the average daily volume of share trading. The volume of daily trades in the pre-shock period is taken as 100 %. The comparison across periods is shown in Figure 6.

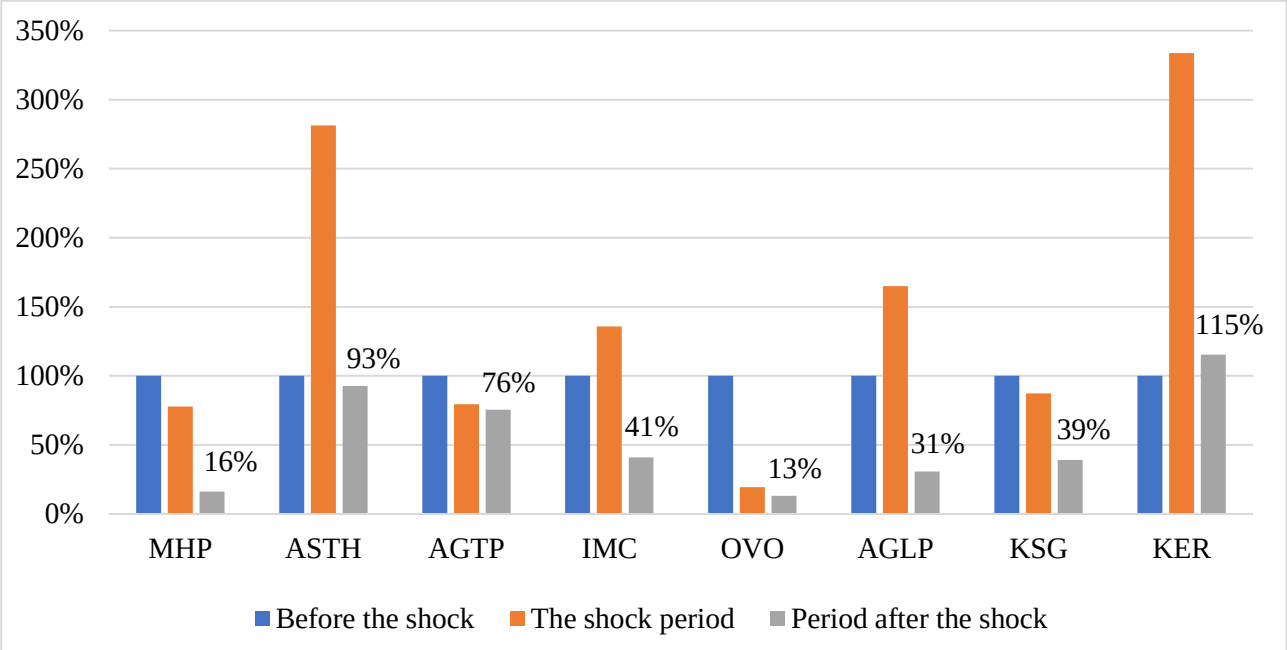

Figure 6. Comparison of the liquidity of agroholdings' assets in the shock and after-shock period, %

Source: calculated and built by the authors.

It should be mentioned that during the shock period the average trading volume increased for a half of the agricultural companies as compared with the before-shock period. This is due to the efforts of companies to increase their capitalization despite falling shares on the stock exchanges. However, in the after-shock period there is a considerable decrease of the trading volumes for all agricultural holdings, except "Kernel", which is quite reasonable. Agroholding Kernel sold almost 30 % of the land to the founder of the company and the largest shareholder (39.16 % of shares). The company received USD 210 million for the deal, according to the website of the Warsaw Stock Exchange (Info STREFA, 2022**)**. Such steps were implemented to reduce business risks and improve liquidity in the medium term. But the majority of agricultural holdings were not able to reach the volume of trades on the stock exchanges that were in the pre-shock period.

Analyzing the investment attractiveness of agricultural holdings, the next step of the research is a forecast of the dynamics of share prices on the stock exchange. For this, the Holt-Winters model is used in the work – a common and relatively simple method of forecasting based on time series. The model includes three components, which serve as methods of smoothing (Winters, 1960).

The computation was made using the weekly prices of the studied company share for three-year periods beginning from 27.10.2019 to 30.10.2022 (time series of

158 points). The next step is to compute the Hold-Winters filtration for the selected time series. In this work, forecasting was carried out in the R (library "forecast"). The results of all agricultural holdings are illustrated in Figure 7.

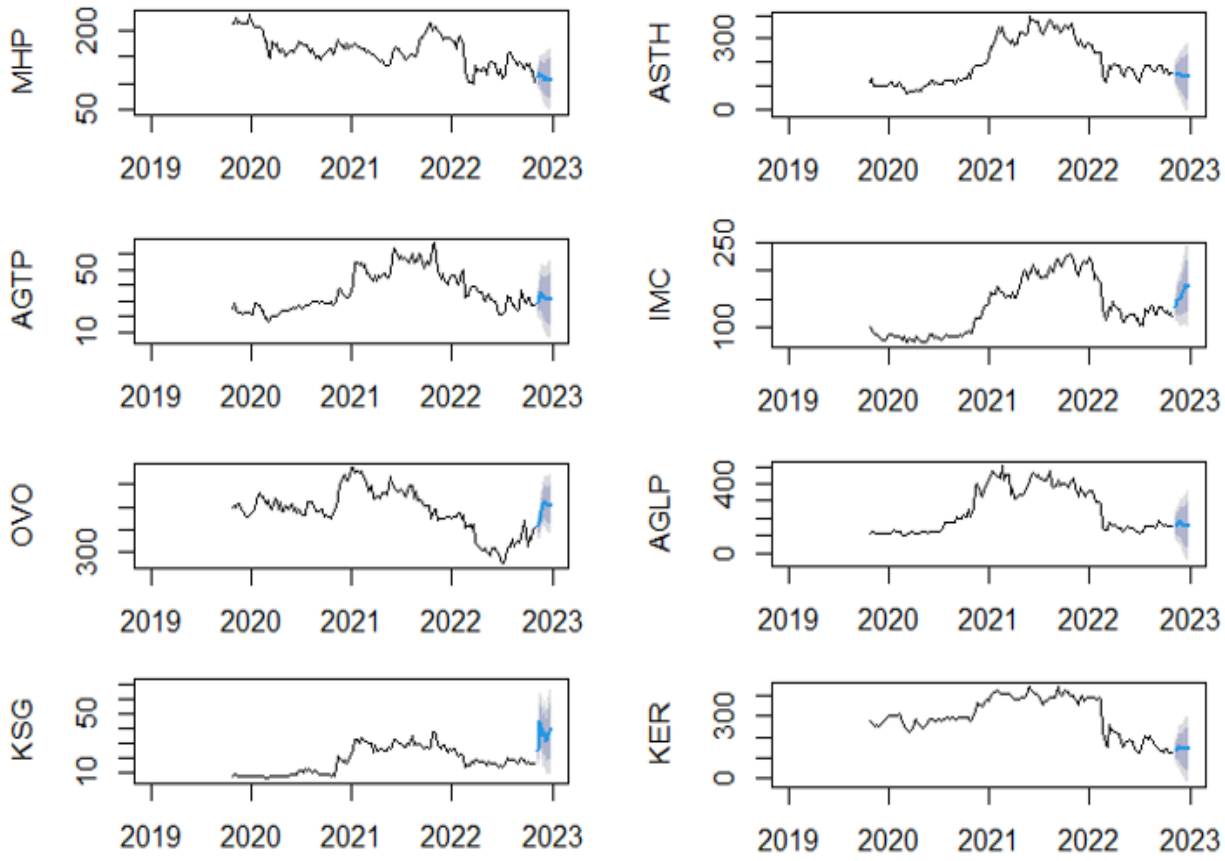

Figure 7. Forecasting price fluctuations of shares of Ukrainian agroholdings on the London Stock Exchange (UAH) according to the Holt-Winters model

Source: calculated and built by the authors.

As a result, three smoothing coefficients were obtained: α means the level smoothing coefficient, β means the trend smoothing coefficient and γ corresponds to the coefficient used for seasonal smoothing. The last step is a forecast of future share price values (for 8 weeks) and an assessment of the relevance of the model for each agricultural holding (Table 6).

The model error was determined as the difference between the actual data after 30.10.2022 and the forecast for this period, the accuracy of the forecast was determined in %. According to the London Stock Exchange, the actual prices of shares of agricultural holdings currently do not have a stable upward trend, which was confirmed by the Holt-Winters model. The analysis of the forecast values of weekly prices for the shares of agroholdings confirms the trend of falling prices for most companies: MHP, ASTH, AGTP, KER. Some companies after the shock period were able to resume the growth of share prices on the LSE (KSG, OVO, IMC). The obtained results confirm that the majority of agricultural holdings with foreign capital will be able to gradually restore their investment attractiveness after crisis periods.

Table 6

Evaluation of forecasts of fluctuations in the prices of shares of Ukrainian agroholdings on the London Stock Exchange according to the Holt-Winters model

Company	Holt-Winters model smoothing coefficients			Indicators of model relevance (model type: adaptive)					
	α	β	γ	RMSE	MAE	MAPE	MASE	Predictive values	Model accuracy, %
1	2	3	4	5	6	7	8	9	10
MHP	0.98	0.03	0.99	119.9	97.2	0.59	27.7	115.4837 128.6173 120.6285 117.7294 109.1894 118.1025 109.5125 115.4413	84.1
ASTH	0.87	0.04	0.99	211.6	187.7	1.02	38.6	153.9888 152.4703 148.6435 151.8142 141.2683 141.0825 137.6685 140.8396	78.2
AGTP	0.93	0.01	0.98	33.1	28.9	0.9	13.1	28.90848 33.66369 36.23366 32.84187 31.98273 30.45290 30.85133 31.75405	91.5
IMC	0.99	0.02	0.54	124.1	110.9	0.89	27.8	128.5059 137.4156 136.7102 134.6683 140.8640 143.7419 149.5434 146.2055	81.2
OVO	0.79	0.02	0.89	381.5	325.2	0.7	37.9	419.2323 442.7375 506.3566 541.0381 554.9721 542.0444 536.5021 550.5732	79.6

Continuation of Table 6

1	2	3	4	5	6	7	8	9	10
AGLP	0.81	0.03	0.99	274.5	240.6	1.09	17.3	162.6391 252.8949 279.2581 260.2937 213.3944 232.8267 242.8355 277.6571	92.5
KSG	0.93	0.04	0.99	19.8	17.2	1.14	31.8	20.18199 28.90819 28.51286 26.17850 26.98461 24.30098 26.12559 29.01285	86.2
KER	0.98	0.02	0.98	231.7	231.8	0.8	20.6	145.8898 162.2044 197.6688 185.0650 173.2930 183.6438 191.9504 196.4876	88.9

Source: calculated by the authors.

Thus, the research proposed a set of methods that allow simultaneously taking into account various features of the manifestation of risks associated with macroeconomic instability. The assessment of investment attractiveness and the forecast regarding the further capitalization of agricultural holdings can be used for decision-making. According to expert reviews, the capitalization of Ukrainian agroholdings cannot yet stabilize and show sustainable growth. Thus, the value of shares of Ukrainian agricultural companies mostly decreased. Our research confirms the assessment of experts, but the capitalization of Ukrainian public agricultural holdings will not grow in the future, unless the fundamental issues of the functioning of agricultural business are resolved. In general, a significant decrease in efficiency and an increase in the riskiness of agribusiness are noted. All risks fall on the shoulders of agricultural holdings and farms. In addition, the obvious risks of rising resource prices are compounded by a large number of unregulated risks.

Observations also indicate that companies are trying to adapt to new conditions. Despite the price and logistical uncertainty in the market and the risks caused by a military invasion, the best anti-crisis strategy for agricultural holdings will be diversification of types of economic activity in agriculture.

Conclusions. To analyze the risks of Ukrainian agroholdings during the shock period and the speed of recovery of their investment attractiveness, a set of approaches

was proposed. This approach made it possible to investigate the depth of the shock and the level of recovery after the shock, to analyze risks based on the VaR and CVaR approach, and to forecast the prospects for the recovery of agricultural holdings.

The investment attractiveness of the agroholdings of Ukraine under war conditions that caused the shock period was investigated. On the average, the shock depth and the recovery level equaled 56 %. It is obvious that agricultural holdings reacted differently to the war shock. Some of them turned out to be less vulnerable to shocks due to a lower depth of fall. Some have shown better chances of recovery.

The application of a variable approach to measuring the risks of agricultural holdings claims that most agricultural holdings demonstrate positive profitability in the post-shock period. But the ratio of post-shock and pre-shock periods is 132 %.

The value at risk was computed using three methods, which produced somewhat different results, however, on the whole, we can state that the investment risk following the shock period did not change and, in the case of the first two methods, became even a bit less. It is worth noting that the choice between VaR and CVaR is not always unambiguous, that is why three approaches were used and the effective one was chosen. The Monte Carlo approach gives the most balanced results with a VaR change of 128 % and a CVaR change of 129 %. This is the only method where the investment risk for both indicators is greater after the shock.

Change of liquidity was analyzed as a ratio of the daily average traded shares. In the second period the trading volume considerably increased, which evidences about active restructuring of portfolios during the shock. The growth of trading during the period of shock was characteristic of agricultural holdings, which were able to support the volume of sales of shares artificially at the expense of their own investors (Astarta and Kernel).

The Holt-Winters model was used to predict future stock prices for producers. The capitalization of the largest Ukrainian agroholdings decreased significantly in 2022, so investment attractiveness is recovering slowly, as evidenced by forecasts based on the model. Most agricultural holdings are far from reaching pre-shock trading volumes. Excluding these two agricultural holdings, the average level of trading after the shock is 41 % of the before-shock period.

The results of this study apply only to agricultural holdings, which is a research limitation. In the agricultural sector of the economy, more than 50,000 agricultural enterprises are engaged in the production of agricultural products, more than 90 % of which are farms. Further research could be related to the use of relevant approaches presented in the paper to analyze the recovery of farms after a shock period. This will make it possible to compare different types of business entities in the public and private sectors of agribusiness. Prospects for further research should be linked to the study of the nature of the impact of the latest risks and threats that have formed in the critically difficult conditions of military operations for agriculture as a whole.

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