"Assessing the impact of the russian invasion on the competitiveness in the Ukrainian insurance market"

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ASSESSING THE IMPACT OF THE RUSSIAN INVASION ON THE COMPETITIVENESS IN THE UKRAINIAN INSURANCE MARKET

Abstract

The full-scale russian invasion and war in Ukraine have inflicted substantial damage on the Ukrainian economy across various sectors. During crises, a common phenomenon is a decline in market competitiveness. This paper seeks to investigate whether the war in Ukraine has resulted in a reduction of competitiveness in the Ukrainian insurance market. To assess this, a range of traditional measures of market concentration, as well as various statistical tests, were applied to three crucial indicators from the Ukrainian insurance market, namely, assets, insurance premiums, and insurance payments for the period from January 1, 2022 to July 1, 2023. The findings suggest that, despite substantial losses incurred by the Ukrainian insurance market due to the invasion, the competition in the market did not experience significant degradation. However, the existing trends indicating a propensity for increased market concentration are cause for concern and demand immediate attention from regulators to prevent the deterioration of the market. To prevent market degradation stemming from current trends, regulatory bodies like the National Bank of Ukraine should carefully monitor adverse developments. They ought to integrate commitments to ensure market competitiveness, complemented by specific quantitative metrics for oversight, into their strategic plans and concepts for the development of the insurance market. Given the persistent threat of russian bombing in Ukraine, a viable and promising direction involves the proactive adoption of digital services and products.

Keywords	Ukrainian insurance market, competitiveness, concentration, war, post-war recovery
JEL Classification	O16, G28, H56, L8, G22

INTRODUCTION

The russian full-scale invasion of Ukraine on February 24, 2022 marked a devastating turning point in the country's recent history, resulting in a severe economic downturn. In 2022, the Ukrainian GDP experienced a dramatic plunge of 29.2%, while industrial production witnessed an alarming decline of 36.9%. A surge in inflation by 26.6% compounded economic challenges. The war also led to a substantial reduction in the work force, declining by 39.2%, and forced over 6 million people to leave the country, highlighting the profound human consequences of the conflict.

The insurance market emerged as one of the primary victims. The number of registered insurance companies decreased by over 25%, the number of insurance contracts dropped by nearly 70%, and the value of insurance premiums and payments lost more than 55%.

Previous research by Plastun et al. (2018) using data from the Ukrainian stock market indicated that crises might trigger a decrease in competitive-

ness. Makarenko et al. (2021) corroborated these findings in the case of the audit market, suggesting potential market degradation (Plastun et al., 2019a, 2019b). Competition is a crucial element in the insurance sector, as it helps reduce risk and uncertainty (G. Antwi & J. Antwi, 2013), contributing to market efficiency.

Understanding the impact on competition in the Ukrainian insurance market, including existing trends, becomes crucial. The insurance market plays a crucial role in the financial system, ensuring stability and risk reduction. The foundation for the market's efficiency and future growth lies in its competitiveness. Regulators must respond effectively to challenges, necessitating a thorough understanding of both existing and potential threats. Despite the significance and timeliness of this matter, there has been a notable absence of focus on the impact of war on competitiveness.

1. LITERATURE REVIEW

The insurance market plays a vital role in the economic system by providing stability, reducing risks, safeguarding economic entities against external shocks, and mitigating volatile economic conditions (Chau et al., 2013; Outreville, 2015; Kuzior et al., 2022; Shkolnyk et al., 2022; Kolinets et al., 2023; Onyshchenko et al., 2023).

The insurance market is a specific segment of the market of financial services, the culture of consumption of which has a decisive influence on the behavior of producers and consumers. In market-oriented countries, insurance services have a significant consumer priority, which increases competition between insurers and changes its forms and means (Nasution et al., 2023; Boiko et al., 2023).

Competition stands as a pivotal element in the development of any market, ensuring efficient resource allocation, fostering balanced development in a country, driving product innovation, enhancing prospects of economic growth, improving the efficient production of financial services, and reducing credit risk (Caminal & Matutes, 2002; Pula et al., 2022; Shin & Lee, 2022).

Competition in the insurance market actually takes place at the level of benefits of insurance services, which are developed by the insurer and implemented thanks to the organization of the sales system, the formation of a network of insurance intermediaries or the introduction of other forms and methods of communication with policyholders (Kral & Janoskova, 2023; Dubyna et al., 2023). The market conditions of the functioning of insurers require the differentiation of their products with the definition of such properties, thanks to which the consumer receives a greater benefit in comparison with the products of competitors (Pramono et al., 2023; Vávrová & Přečková, 2023). For insurance services, the advantages are determined primarily due to the abilities and competencies of the company's personnel, the level of professionalism and creativity of which directly affects customers' choice of services of a particular company.

Fostering a competitive environment provides firms with continuous incentives to enhance production and distribution efficiency, adopt superior technology, and innovate (Cook et al., 2007; Duong & Dang, 2023). In the realm of financial services, including insurance, there is a responsibility to mobilize long-term savings for building critical infrastructure assets, such as roads, ports, power plants, dams, etc., contributing significantly to economic growth (Haiss & Sümegi, 2006; Plastun et al., 2019a, 2019b; Onopriienko et al., 2023; Danylyshyn et al., 2023).

While competition is generally seen as beneficial, there are instances where it may be less efficient, and in some cases, a monopoly might be considered a better solution for the market (Feo & Hindriks, 2009). A monopoly, for instance, might provide better coverage to those purchasing insurance but at the cost of limiting participation, and it can exploit its market power through cross-subsidization between different risk types.

The degradation of competition in the insurance market, as noted by OECD (1998), may drive premiums down to a point where the risk of failure becomes high, leading to various consequences such as increased uncertainty, inefficient allocation of resources, diminished product innovation, reduced market efficiency (Sanderson et al., 2021), and even insolvency (Bikker & Bos, 2005). Alhassan and

Biekpe (2016) found a positive effect of competition on cost and profit efficiency, validating the "quiet-life" hypothesis, which suggests that competition improves efficiency.

The effects of asymmetric information on competition among insurers have been investigated in several papers, following the seminal contributions by Rothshild and Stiglitz (1976).

Tsymbaliuk et al. (2021) examined the competitiveness in the Ukrainian insurance market. They revealed that the crisis of 2014–2015 led to a significant reduction in competitiveness in the insurance sector, although competitiveness did not change significantly during the pandemic. Dyakonova et al. (2020) explored quantitative methods for estimating the competitiveness of insurance companies in the context of sustainable development.

Market concentration is one of the main characteristics of the market structure. Market concentration is determined by the presence or absence of leading sellers in the market, controlling a significant share of it, having market power, and establishing their own rules. High concentration creates favorable conditions for the emergence of a monopoly, which threatens the normal functioning of the market mechanism and limits competition. Increasing monopolization in the market often provokes a negative impact on both the market itself and the state's economy as a whole (Savchuk et al., 2021).

Zhuravka et al. (2019) analyzed concentration in the Ukrainian insurance market, finding significant concentration in the life insurance market and insignificant concentration in the risk insurance market. Sanderson et al. (2021) explored the evolution of competition in the context of an economy transitioning from hyperinflation and found no significant difference in competition during periods with different inflation regimes.

Despite various studies on competition in the insurance market, none have focused on the influence of war on competitiveness. The situation in Ukraine is unique for modern economic systems, making its examination crucial. This paper aims to fill this gap by exploring competitiveness in the Ukrainian insurance market in war conditions.

2. DATA AND METHODOLOGY

This study is based on quarterly data obtained from the National Bank of Ukraine (NBU, n.d.). covering the period from January 1, 2022 to July 1, 2023. The chosen timeframe is justified by the initiation of the full-scale invasion on February 24, 2022 and the availability of the latest data at the time of the research. Various indicators, including assets, insurance premiums, and insurance payments, are employed to analyze market competitiveness.

The primary hypothesis examined is whether the russian invasion has resulted in decreased competitiveness in the Ukrainian insurance market. The methodology proposed by Plastun et al. (2018) and Makarenko et al. (2021) is adopted for hypothesis testing. This methodology encompasses specific indicators commonly used for market competitiveness analysis, such as the Herfindahl-Hirschman Index (HHI), the Rosenbluth index, Comprehensive concentration index (CCI), Lorenz curve, the Gini coefficient, the Entropy index, the Lerner index, and concentration ratio, among others. Additionally, supplementary statistical techniques, including the Kruskal-Wallis test and regression analysis with dummy variables, are employed to enhance result authenticity.

In the initial phase of analysis, specific statistical tests are applied to provide preliminary evidence supporting the tested hypothesis. The data is categorized into groups (pre-war and war) and scrutinized for their affiliation to the same general population. To avoid methodological bias, both parametric (ANOVA analysis) and non-parametric tests (Mann-Whitney tests) are employed. The Null Hypothesis (*H0*) posits that the data belong to the same population, and the rejection of this null hypothesis signifies differences in the analyzed data groups, indicating changes in the market.

Upon obtaining preliminary statistical evidence favoring the tested hypothesis (indicating changes in the Ukrainian insurance market), the analysis proceeds to the quantitative assessment of competitiveness. Specific indicators are utilized for this purpose, and a comprehensive description of these indicators is provided in Appendix A.

As an additional measure of market inequality, the Lorenz curve is employed, offering a visual interpretation of market unevenness. The graph represents the cumulative percentage of companies on the x-axis and the cumulative percentage of market share on the y-axis. In an ideally equal distribution, the bisector emanates from the starting point of the coordinate system. Any deviation from this theoretical empirical distribution indicates a degree of inequality observed in the market.

3. EMPIRICAL RESULTS

The analysis begins with an examination of the overall situation in the Ukrainian insurance market to establish preliminary evidence supporting the impact of the war. The results are presented in Table 1.

As evident from Table 1, all key indicators, except for assets, have shown a significant decline. The number of insurance contracts, as well as gross insurance premiums and payments, suggests that over half of the market has vanished during this period. The damage is colossal, and the trends are decidedly negative, as illustrated in Figure 1."

Next, statistical tests are used to confirm/reject hypothesis. Descriptive statistics for key indicators of the Ukrainian insurance market in two dimensions (pre-invasion and post-invasion) are reported in Table 2.

Based on data from Table 2, it can be inferred that the situation in the Ukrainian insurance market underwent significant changes after the russian invasion. Notably, average insurance payments and premiums experienced a 50% decrease. Moreover,

Table 1. Key indicators of the Ukrainian insurance market over the period January 1, 2022 – July 1, 2023

Parameter	01.01.22	01.04.22	01.07.22	01.10.22	01.01.23	01.04.23	01.07.23	Change 2023 to 2022, %
The number of registered insurance companies, units	155	145	142	139	128	122	115	−26%
The number of insurance contracts for the period, thousands of units	131,561.9	20,102.1	39,705.4	60,380.3	88,003.0	20,228.9	40,775.7	−69%
Assets on the balance sheet, million UAH	64,209.2	64,573.3	65,904.4	70,869.0	70,298.3	70,480.3	70,785.3	10%
Gross insurance premiums, million UAH	49,708.0	9,680.2	17,656.4	28,573.7	39,661.8	10,116.4	21,354.7	−57%
Gross insurance payments, million UAH	17,958.3	3,180.4	6,016.4	9,502.3	13,001.4	3,839.8	7,817.5	−56%

Table 2. Descriptive statistics for key indicators of the Ukrainian insurance market: the case of pre- and post-invasion data

Parameter	Assets		Insurance premiums		Insurance payments	
	pre	post	pre	post	pre	post
Average	562,464	626,419	334,698	158,614	155,524	68,943
Standard error	86,461	115,525	51,024	28,812	33,805	13,912
Median	162,729	115,592	120,294	25,321	23,385	5,305
Standard deviation	919,091	1,228,050	542,396	306,271	359,352	147,881
Sample variance	844,728,999,283	1,508,106,663,716	294,193,443,424	93,801,865,343	129,134,132,837	21,868,920,659
Excess	6.85	9.13	7.42	6.79	27.42	8.33
Asymmetry	2.65	2.98	2.66	2.69	4.63	2.94
Interval	4,758,338	6,806,960	2,885,516	1,509,053	2,791,624	702,471
Minimum	56,113	32,714	642	−2,549	0	0
Maximum	4,814,451	6,839,674	2,886,159	1,506,504	2,791,624	702,471
Sum	63,558,419	70,785,329	37,820,886	17,923,424	17,574,237	7,790,608
Count	113	113	113	113	113	113
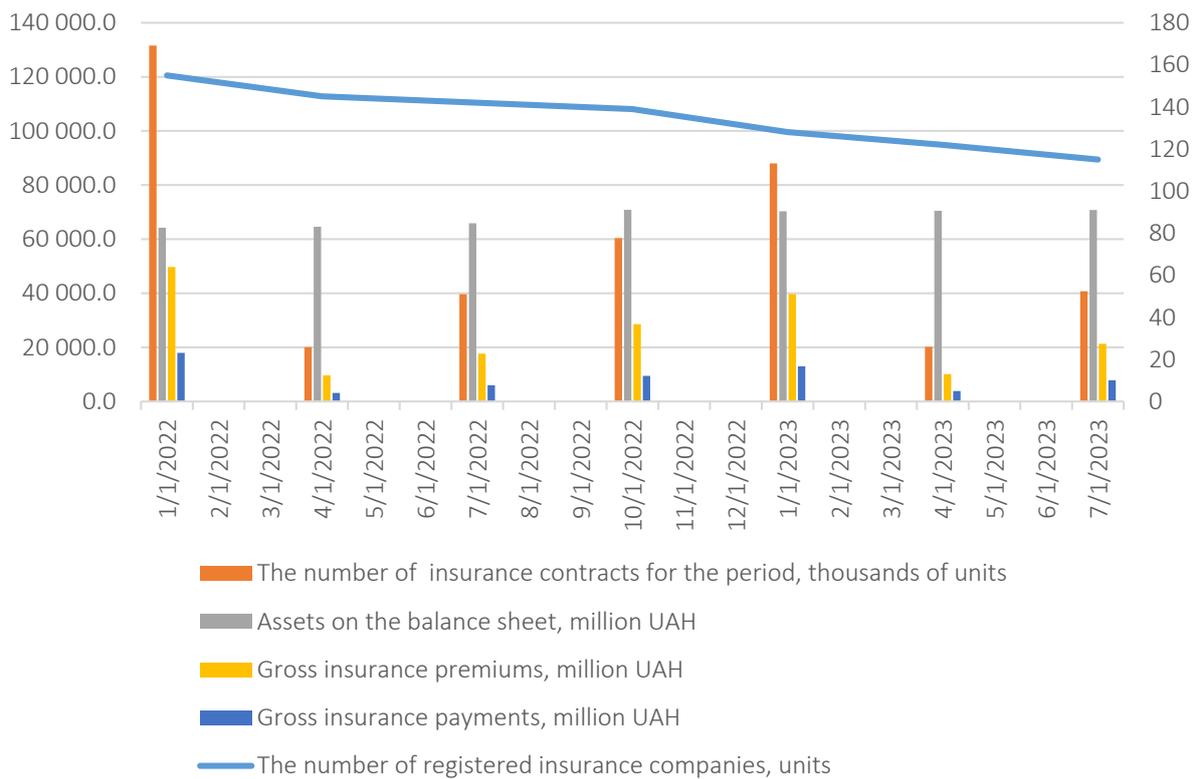
Figure 1. Dynamics of key indicators of the Ukrainian insurance market
over the period January 1, 2022 – July 1, 2023

internal properties of the data exhibit substantial alterations, such as notable differences in excess and asymmetry, providing indirect support for the tested hypothesis.

To validate these findings, statistical tests were conducted, commencing with parametrical ANOVA analysis. The results of the ANOVA analysis are presented in Table 3.

Table 3. ANOVA analysis results: the case of pre- and post-invasion data

Parameter	Assets	Insurance premiums	Insurance payments
F	0.19	9.03	5.61
F critical	3.88	3.88	3.88
P value:	0.66	0.00	0.02
Null hypothesis	not rejected	rejected	rejected

The results reveal no statistically significant differences in assets before and after the invasion. However, the datasets for insurance premiums and payments show discernible distinctions, offering supplementary evidence that the

situation in the Ukrainian insurance market has undergone significant changes.

Given that ANOVA analysis relies on the assumption of data normality, additional tests were conducted to mitigate potential methodological bias associated with data distribution. Mann-Whitney tests, suitable for non-normally distributed data, were employed. The outcomes of the Mann-Whitney tests are delineated in Table 4.

Table 4. Mann-Whitney tests: the case of pre- and post-invasion data

Parameter	Assets	Insurance premiums	Insurance payments
Adjusted H	3.82	18.60	11.18
d.f.	1	1	1
P value	0.05	0.00	0.00
Null hypothesis	rejected	rejected	rejected

It is evident that pre-invasion data and post-invasion data belong to different general populations. This provides evidence in favor of changes in pre- and post-invasion results for all of the analyzed indicators.

Table 5. Indicators of Ukrainian insurance market concentration for the case of Assets, 2022–2023

Indicator	01.01.22	01.04.22	01.07.22	01.10.22	01.01.23	01.04.23	01.07.23
Concentration ratio (CR1)	**7.43%**	**7.88%**	**8.22%**	**8.10%**	**8.69%**	**9.17%**	**9.66%**
Concentration ratio (CR4)	24.45%	25.18%	26.49%	27.46%	28.56%	29.31%	30.36%
Hirschman Index (HHI)	0.03	0.03	0.03	0.03	0.04	0.04	0.04
Rosenbluth Index	0.09	0.09	0.09	0.09	0.09	0.08	0.08
Comprehensive concentration index (CCI)	0.09	0.09	0.06	0.07	0.07	0.08	0.08
Entropy index	9.60%	9.66%	9.69%	9.80%	9.95%	10.14%	10.24%
Gini coefficient	0.29	0.28	0.28	0.26	0.26	0.25	0.25

In summary, both the general analysis and statistical tests offer compelling evidence of a severe crisis in the Ukrainian insurance market caused by the russian invasion in Ukraine. The next step is to explore how competition in the Ukrainian insurance market reacted.

Let's start with an analysis of the competitiveness in the market based on the "Assets" indicator. The results of the market concentration indicators (Concentration ratio (CR1), Concentration ratio (CR4), Hirschman Index (HHI), Rosenbluth Index, Comprehensive concentration index (CCI), Entropy index, and Gini coefficient) analysis for the case of assets are presented in Table 5.

The dynamics are mixed, showing an overall tendency toward increased market concentration (CR ratios), which supports the notion of lower competitiveness in the Ukrainian insurance market after the russian invasion. However, these changes are relatively insignificant, and some other indicators provide opposing evidence. Thus, the evidence related to the hypothesis of interest is mixed.

To offer a visual interpretation of the inequality in the Ukrainian insurance market for the case of assets, the Lorenz curve is employed (see Figure 2).

The results support the presence of inequality in the Ukrainian insurance market, but the changes caused by the russian invasion are insignificant. General results of concentration indicators analysis are presented in Table 6.
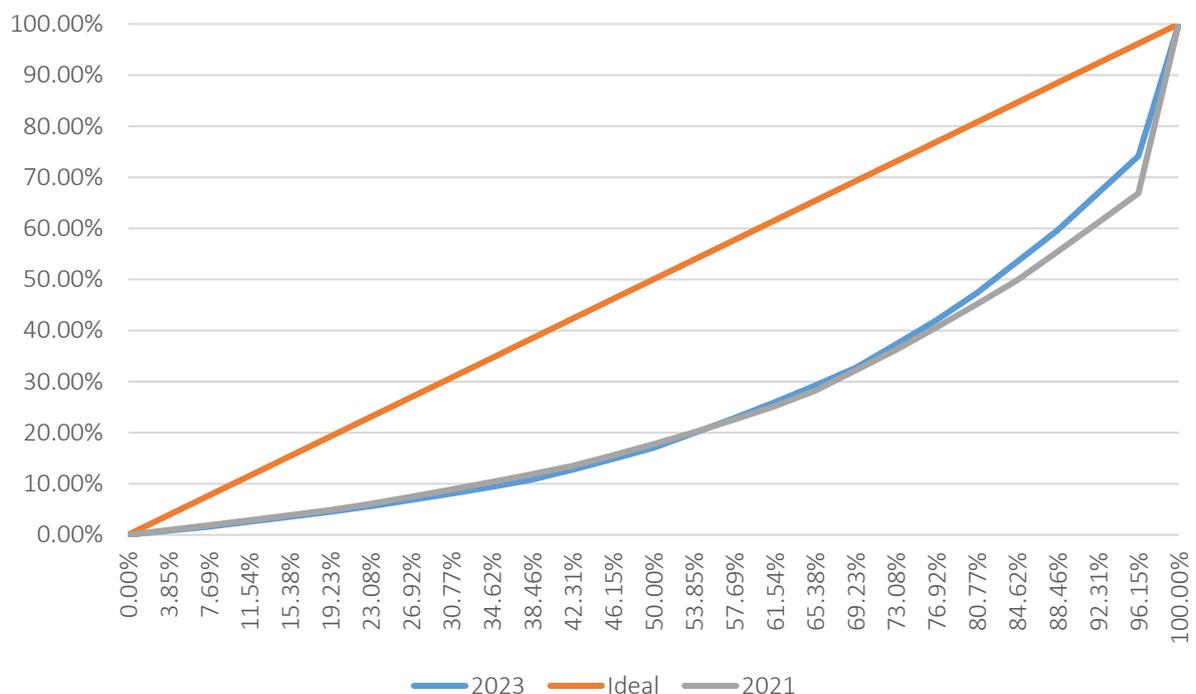
Figure 2. Lorenz curve for the case of assets in the Ukrainian insurance market: pre- and post-invasion data

Table 6. General results of competitiveness analysis in the Ukrainian insurance market for the case of "Assets"

Indicator	Before the Invasion	After Invasion
Concentration ratio (CR1)	Low concentration	Low concentration
Concentration ratio (CR4)	Low concentration	Low concentration
Hirschman Index (HHI)	Low concentration	Low concentration
Rosenbluth Index	Low concentration	Low concentration
Comprehensive concentration index (CCI)	Low concentration	Low concentration
Entropy index	A low level of uncertainty, and hence a high probability of the monopoly or oligopoly presence	A low level of uncertainty, and hence a high probability of the monopoly or oligopoly presence
Gini coefficient	Low concentration	Low concentration
Lorenz curve	Insignificant market inequality	Insignificant market inequality

Table 7. Indicators of market concentration for the case of Net earned insurance premiums, 2022–2023

Indicator	01.01.22	01.04.22	01.07.22	01.10.22	01.01.23	01.04.23	01.07.23
Concentration ratio (CR1)	7.57%	8.30%	8.57%	8.38%	8.42%	8.34%	8.41%
Concentration ratio (CR4)	25.20%	26.45%	27.02%	27.13%	27.72%	28.32%	28.54%
Hirschman Index (HHI)	0.03	0.03	0.03	0.03	0.04	0.04	0.04
Rosenbluth Index	0.11	0.11	0.10	0.11	0.10	0.10	0.10
Comprehensive concentration index (CCI)	0.10	0.10	0.06	0.06	0.07	0.08	0.08
Entropy index	8.96%	8.99%	9.18%	9.14%	9.55%	9.51%	9.73%
Gini coefficient	0.32	0.31	0.30	0.30	0.27	0.30	0.29

Based on the analysis of the "Assets" indicator, it can be concluded that the level of competitiveness of the Ukrainian insurance market has changed in-significantly. No serious degradation of the market is detected. Still, tendencies are negative: the market moves from more competitive to less competitive.
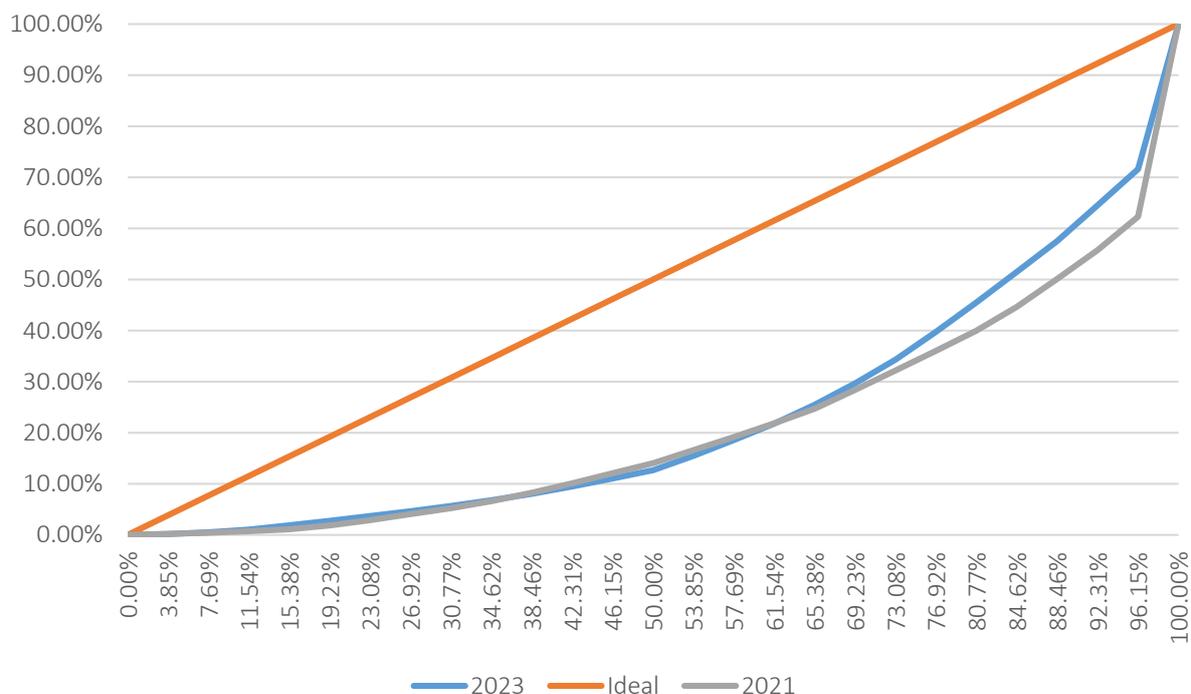
Figure 3. Lorenz curve for the case of Net earned insurance premiums in the Ukrainian insurance market: pre- and post-invasion data

The next indicator to be explored is "Net earned insurance premiums." Results of the market concentration indicators analysis are presented in Table 7.

Overall results are similar to those obtained for the case of "Assets" with similar conclusions about the tested hypothesis. The same is true for the Lorenz curve, which is presented in Figure 3.

General results of concentration indicators analysis are presented in Table 8.

Again, results are in line with those for the case of the "Assets" indicator. The last indicator to be explored is insurance payments. Market concentration indicators for this indicator are presented in Table 9.

As can be seen, general tendencies are similar to those for the indicators "Assets" and "Insurance premiums," with one key difference: market concentration for the case of insurance payments has decreased over the analyzed period. These conclusions are confirmed by the Lorenz curve (see

Table 8. General results of competitiveness analysis in the Ukrainian insurance market for the case of "Insurance premiums"

Indicator	Before the Invasion	After Invasion
Concentration ratio (CR1)	Low concentration	Low concentration
Concentration ratio (CR4)	Low concentration	Low concentration
Hirschman Index (HHI)	Low concentration	Low concentration
Rosenbluth Index	Low concentration	Low concentration
Comprehensive concentration index (CCI)	Low concentration	Low concentration
Entropy index	A low level of uncertainty, and hence a high probability of the monopoly or oligopoly presence	A low level of uncertainty, and hence a high probability of the monopoly or oligopoly presence
Gini coefficient	Low concentration	Low concentration
Lorenz curve	Insignificant market inequality	Insignificant market inequality

Table 9. Indicators of market concentration for the case of Insurance payments, 2022–2023

Indicator	January 1, 2022	April 1, 2022	July 1, 2022	October 1, 2022	January 1, 2023	April 1, 2023	July 1, 2023
Concentration ratio (CR1)	15.74%	8.69%	8.28%	10.32%	9.58%	9.43%	9.02%
Concentration ratio (CR4)	37.24%	30.67%	29.75%	31.34%	30.68%	34.63%	33.53%
Hirschman Index (HHI)	0.05	0.04	0.04	0.04	0.04	0.05	0.05
Rosenbluth Index	0.12	0.11	0.10	0.11	0.10	0.10	0.10
Comprehensive concentration index (CCI)	0.15	0.13	0.08	0.08	0.08	0.09	0.09
Entropy index	8.99%	9.30%	9.40%	9.20%	9.45%	9.79%	9.90%
Gini coefficient	0.42	0.38	0.33	0.33	0.30	0.31	0.30

Table 10. General results of competitiveness analysis in the Ukrainian insurance market for the case of "Insurance payments"

Indicator	Before the Invasion	After Invasion
Concentration ratio (CR1)	Low concentration	Low concentration
Concentration ratio (CR4)	Low concentration	Low concentration
Hirschman Index (HHI)	Low concentration	Low concentration
Rosenbluth Index	Low concentration	Low concentration
Comprehensive concentration index (CCI)	Low concentration	Low concentration
Entropy index	A low level of uncertainty, and hence a high probability of the monopoly or oligopoly presence	A low level of uncertainty, and hence a high probability of the monopoly or oligopoly presence
Gini coefficient	Low concentration	Low concentration
Lorenz curve	Significant market inequality	Insignificant market inequality
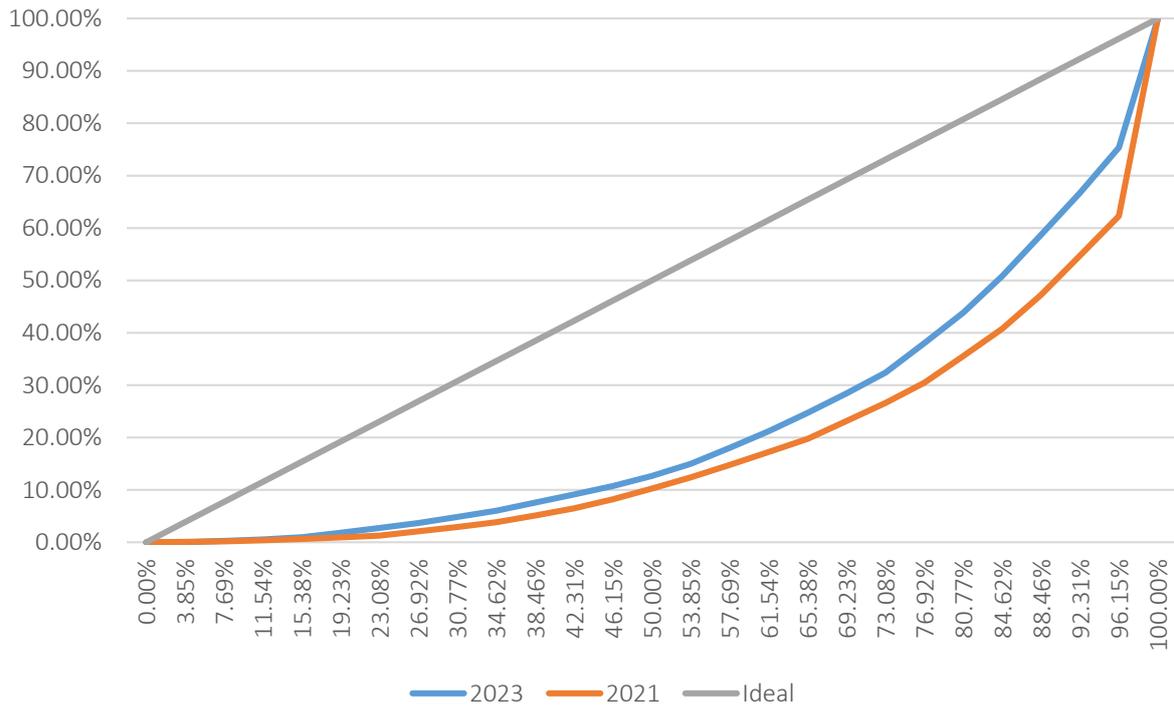
Figure 4. Lorenz curve for the case of insurance payments in the Ukrainian insurance market: pre- and post-invasion data

Figure 4). This is direct evidence against the tested hypothesis.

General results of concentration indicators analysis for the case of "Insurance payments" indicator are presented in Table 10.

Overall, we find no convincing confirmations to the basic idea: a full-scale invasion decreased competitiveness in the Ukrainian insurance market. In most of the analyzed indicators and parameters, tendencies are clear: the level of competitiveness is decreasing; in some other cases, evidence is mixed. But the market hasn't changed its state yet. This is still a highly competitive environment.

These results are in line with those from Sanderson et al. (2021) for the case of different inflation regimes (high/low) of inflation. Still, to avoid the degradation of the market based on existing tendencies, regulators (National Bank of Ukraine) should pay attention to existing negative processes.

First of all, the National Bank of Ukraine should incorporate in its strategic documents and con-

cepts for the development of the insurance market a statement related to ensuring competitiveness in the market, including quantitative parameters to be controlled. For this purpose, the methodology provided in this paper can be used. The recommended set of indicators allows effectively monitoring and assessing the level of concentration in the market and existing tendencies. This information will be a reliable basis for further regulatory actions.

According to OECD (1998), potential responses to challenges like this from the regulator vary from entry limits and constrained premiums to special exemptions and prudential regulation. A potential promising direction for the case of Ukraine, because of the constant threat of russian bombing, is the active use of digital services and products. A series of related papers (Voronenko et al., 2021, Voronenko et al., 2022a, 2022b) provides a description of the innovative potential in the conditions of digital transformation, as well as specific aspects like cybersecurity and proper risks.

Volosovych et al. (2021) provides the following list of technologies to be incorporated into the insurance market within its digital transformation: Chatbots, telematics, the Internet of

Things, machine learning, artificial intelligence, predictive analytics, etc.

Additional actions can include strengthening control over compliance in the market, tariff policies, and fair pricing in the market, as well as the expansion of new instruments and products in the Ukrainian insurance market, especially those related to war-caused risks.

CONCLUSIONS AND IMPLICATIONS

This paper explores the shifts in competitiveness in the Ukrainian insurance market caused by the full-scale russian invasion and war in Ukraine. The primary hypothesis under examination is whether the russian invasion has diminished competitiveness in the Ukrainian insurance market. To investigate this, various conventional measures of market concentration, such as the Hirschman Index, Lerner Index, Comprehensive Concentration Index, Entropy Index, Gini coefficient, etc., along with additional methods like parametric and non-parametric statistical tests (ANOVA analysis and Mann-Whitney tests), were applied to three key indicators from the Ukrainian insurance market (assets, insurance premiums, and insurance payments) covering the period from January 1, 2022 to July 1, 2023.

An initial analysis of the general situation in the Ukrainian insurance market aimed to provide preliminary evidence of the war's influence. The findings indicated a substantial decline, with gross insurance premiums/payments decreasing by 56-57% and the number of insurance contracts plummeting by 69%. This suggests that the Ukrainian insurance market suffered significant losses. Descriptive statistics and statistical tests confirmed these conclusions, revealing that the majority of observed differences were statistically significant.

Despite the visible trends toward increased market concentration, the overall competitiveness of the Ukrainian insurance market did not exhibit a serious decline. The market maintained its characteristics of low concentration. Consequently, the hypothesis of reduced competitiveness due to the war is rejected.

However, the identified trends are deemed precarious, prompting the provision of several regulatory recommendations in this paper to prevent market degradation resulting from the ongoing war.

AUTHOR CONTRIBUTIONS

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Funding acquisition: Svitlana Laichuk, Liudmyla Rudenko, Yuliia Mashyna.
Investigation: Tetiana Guzenko.
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Supervision: Alex Plastun.
Validation: Tetiana Guzenko.
Visualization: Svitlana Laichuk.
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Writing – review & editing: Yuliia Mashyna.

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APPENDIX A

Table A1. Indicators to assess competitiveness

Indicator	Formula	Description
Concentration ratio	$CRn = R_1 + R_2 + \ldots + R_n,$ CR_n – concentration ratio; n – the number of the largest market participants; R_i – share of the market held by the i-th participant	Concentration ratio is used to measure the level of market control of the largest firms in the market and to illustrate the degree to which market is oligopolistic. The concentration ratio is the percentage of market share held by the largest n firms in an industry. Depending on the value of the CR the level of market competition can be characterized as follows (based on Naldi and Flamini, 2014): - 0% – no concentration. Means perfect competition; - 0%-50% – low concentration. Depending on concrete size of the CR market competition ranges from perfect competition to an oligopoly; - 50%-80% – medium concentration. Usually is typical for the oligopoly; - 80%-100% – high concentration. Market ranges from an oligopoly to monopoly; - 100% – total concentration. The market is monopoly.
Herfindahl-Hirschman Index (HHI)	$HHI = \sum_{i=1}^{n} \left(\frac{R_i}{R} \right)^2$	HHI is used to measure the size of firms *in relation to the whole market. This is an indicator of the competition level in the market.* It ranges in the interval [0;1] (based on Hirschey, 2008): - 0 – no concentration; - from 0 to 0.1 – low concentration; - from 0.10 to 0.18 – medium concentration; - above 0.18 – high concentration
The Rosenbluth Index	$I_R = \frac{1}{2 \cdot \sum_{i=1}^{n} (i \cdot R_i) - 1}$	The Rosenbluth Index includes not only the firm market share, but also the firm rank. The Rosenbluth Index deviates in the range [1/n;1]. The higher number of the Index the more monopolized the market is.
Comprehensive concentration index (CCI)	$CCI = R_1 + \sum_{i=2}^{n} R_i^2 \cdot \left(1 + \left(1 - R_i \right) \right)$	Comprehensive concentration index reflects both relative dispersion and absolute magnitude of the biggest market participant share. CCI ranges from 0 to 1. The higher the CCI is the less competitive is market.
The entropy index	$E = \frac{1}{n} \sum_{i=1}^{n} R_i \cdot \ln \frac{1}{R_i}$	The entropy index is a measure of "evenness" – the extent to which groups are evenly distributed among organizational units. It can also be interpreted as the difference between the diversity (entropy) of the system and the weighted average diversity of individual units, expressed as a fraction of the total diversity of the system. Small values of the Entropy Index reflect high concentration.
The Gini coefficient	$G = \frac{\sum_{i=1}^{n} \sum_{j=1}^{n} \left| R_i - R_j \right|}{2n^2 \bar{R}}$	The Gini coefficient measures the inequality among values of a frequency distribution (for example, market shares). The Gini coefficient deviates from 0 (perfect competition in the market) to 1 (monopoly).