



INFORMATION BASE AND ANALYTICS OF THE REAL ESTATE MARKET OF UKRAINE

December 2022



Bona consulta homini optima est!
Good advice is the best!

INTRODUCTION

The lack of a reliable analytical database of the purchase and sale of residential, commercial and industrial properties remains one of the biggest obstacles in obtaining reliable data on its real value.

This considerably complicates the process of carrying out a valuation, requires considerable effort from the expert to find market analogues of the sale, and reduces the accuracy and reliability of the results of such work.

The specified problem is quite significant for appraisers and their customers. It does not require detailed explanations, but requires appropriate efforts for its gradual solution.

VERITEX group forms the information and analytical base of the real estate market of Ukraine, using the appropriate automated and calculation products, application program packages. This makes it possible to effectively use such a database, to obtain generalized results in a planned manner, to formulate the patterns of the modern real estate market, as well as to forecast its priority directions for further development.

The creation of the primary electronic database is carried out by monitoring and accumulating information flows from the existing real estate market and their subsequent in-depth processing. All this becomes possible through the use of methods of mathematical and statistical analysis, geospatial and cluster analysis, machine learning and modeling, in particular neural networks and combinations of these methods.

The use of modern methods of database management (PostgreSQL), geographic information systems (QGIS) and a script library (Python) allows this initial analysis to be carried out as efficiently as possible.

The main principles, on the basis of which the information and analytical base is built, are:

- maximum coverage of the existing primary information base of the real estate market of Ukraine;
- application of accurate mathematical, statistical and other most suitable modern models and criteria for the analysis of large information arrays at all stages of primary database processing;
- conducting a full probabilistic and statistical analysis of the primary information base for all categories of real estate with obtaining the main parameters of their market state and development evolution;
- constant checking of intermediate and final results for compliance within the framework of the applied analytical model;

- constant comparison of the developed analytical apparatus and the obtained results with the most famous and recognized domestic and foreign works of this direction.

The introduction of these principles ensures high reliability and credibility of the obtained results and the conclusions formulated on their basis.

This all corresponds to the main goal, aimed at creating and providing all interested organizations and specialists with reliable analytics of the state, trends and forecast of the development of the real estate market with a detailed analysis of the impact of the main pricing factors.

INITIAL INFORMATION BASE AND ITS PRIMARY PROCESSING

Obtaining the initial information base and its primary processing form the basis of the following analysis of the real estate market and directly affect the results of the entire analysis. Therefore, considerable attention is paid to this initial and rather difficult stage of work.

According to its structure, the initial information and analytical database of the residential real estate market consists of the following blocks:

UNIT OF APARTMENTS: primary and secondary market;

UNIT OF LAND PLOTS: development, agricultural, industrial purposes;

UNIT OF HOUSEHOLDS: separated from land plots and together with them.

The processing of arrays of primary data for all three specified blocks of real estate is carried out on a single methodological basis using the analytical tools mentioned above. This ensures the unification of the methodology itself and the possibility of conducting a comparative analysis of the results for individual real estate groups.

1. INFORMATION AND ANALYTICAL UNIT OF THE APARTMENT MARKET

As of December 2022, the database in the context of the secondary apartment market includes about 1 million 660 thousand unique offers throughout Ukraine. The majority of this market structure (>90%) consists of 1-, 2-, and 3-room apartments. The share of these apartments in terms of value is also the main one.

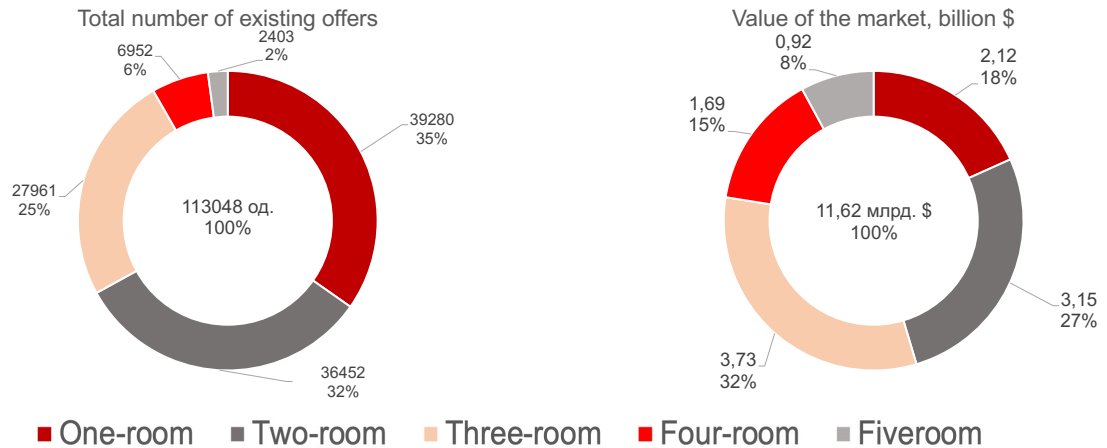


Fig. 1. 1. Volume of the secondary apartment market in Ukraine as of December 2022

The total number of existing offers for sale in 2022 amounted to more than 113,000 apartments (Fig. 1.1). The largest share of offers for sale is transferred to one- and two-room apartments, which for them is respectively 35% and 32% of the total number of apartments offered for sale. For three-room apartments, this share is also significant, reaching 25%. Accordingly, 8% of the total number of offers remains for 4-, 5- and more-room apartments.

In monetary terms the value of the secondary apartment market in Ukraine for December amounted to more than 11.60 billion dollars. USA (Fig. 1.1). Two- and three-room apartments account for the largest share, 27 per cent and 32 per cent respectively, while one-room apartments account for 18 per cent. The share of 4-room apartments is already 15%, 5- (and more) room apartments - 8%.

This picture is quite natural, as it reflects the structure of the housing stock, the construction of which has been historically formed in recent decades. Statistical regularities of the distribution of key characteristics and the parameters of these distributions, which allow for their full probabilistic - statistical analysis are important for property valuation. The importance of

obtaining such parameters of the distribution of value indicators is determined by their nature, which has a probabilistic basis.

Indicators of the volume of the secondary market in Ukraine for the period of 2021-2022 dynamically characterize the general picture, considering the influence of various factors that restrained or, on the contrary, revived market activity (Fig. 1.2, 1.3). Thus, we can see that April 2022 was the most shocking for the market, both in terms of quantitative and value results. It is obvious that the cause was the beginning of a full-scale war, which shook the relative stability. However, by the end of the year, the market showed tendencies towards recovery, although it has not yet reached pre-war indicators.

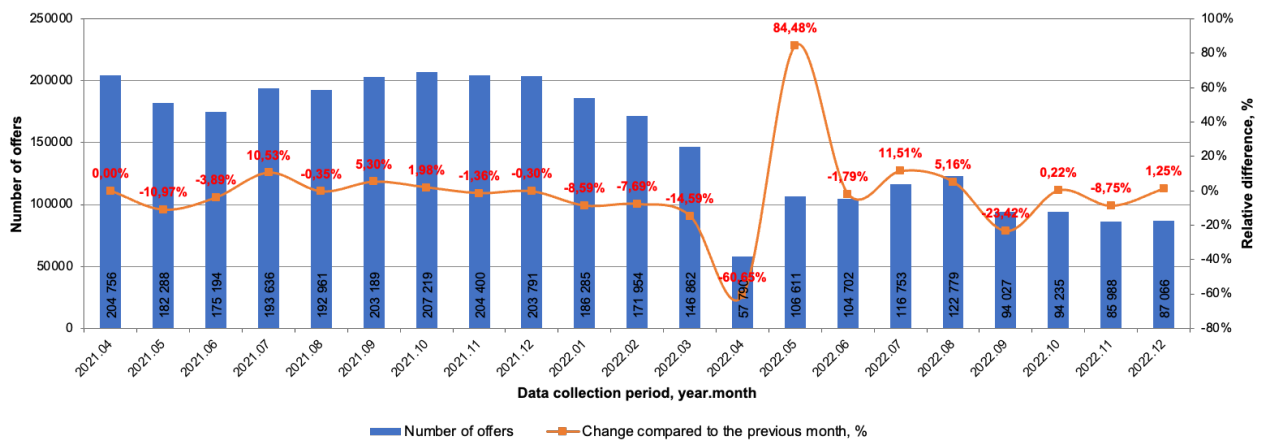


Fig. 1.2. Evolution of the number of offers on the secondary market of apartments in Ukraine, 2021-2022

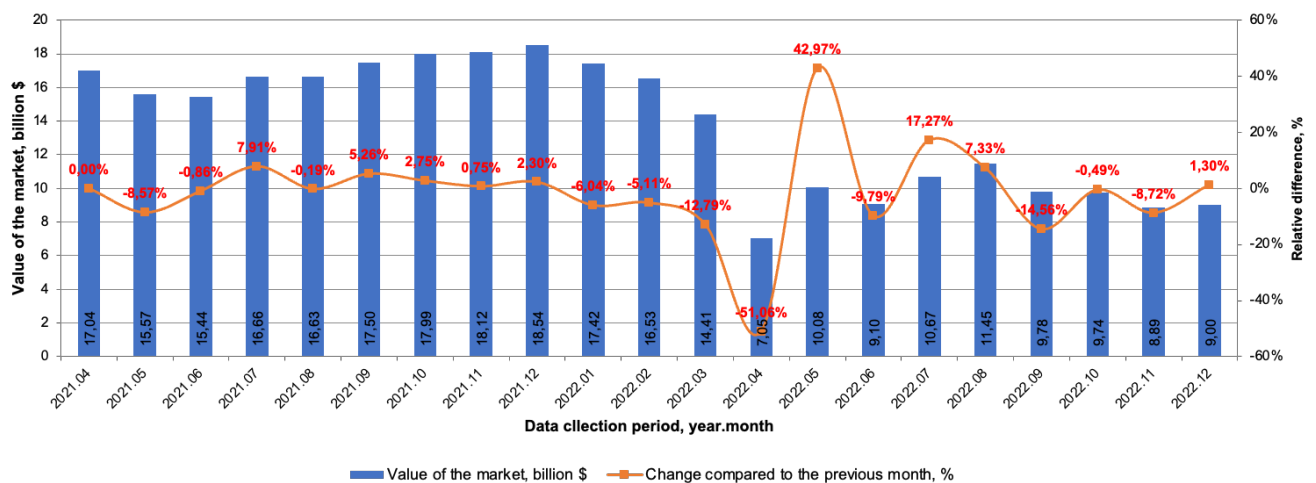


Fig. 1.3. Evolution of the value of the secondary market of apartments in Ukraine, 2021-2022 , billion \$

A statistical analysis of the total amount of available primary information after its initial filtering according to the Romanovsky criterion for statistical "outliers" shows that the density of distribution of one of the main and widely used monetary criteria - the cost of 1 sq. meter of area is not symmetrical and has a clearly expressed positive skew – the asymmetric distribution is right-tailed (Fig. 1.4).

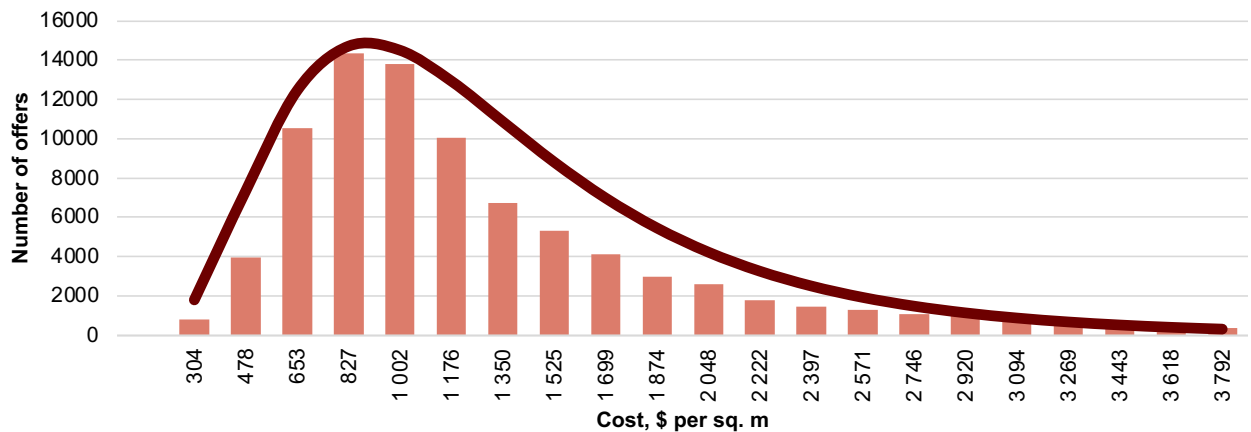


Fig. 1.4. Density distribution cost of 1 m² on the secondary apartment market of Ukraine as of December 2022

As the analysis shows, all distributions of statistical data for separate time periods and geographic regions of this key financial parameter, which is widely used in the valuation of residential and industrial premises, have such appearance.

Based on this, a multiple assessment of the correspondence of the distributions or their "agreement" with the most well-known theoretical distributions was performed. Such a check was conducted using one of the most statistically powerful criteria - the Pearson χ^2 test. Multiple calculations made it possible to conclude that the closest theoretical distribution to the obtained statistical samples is the logarithmic normal distribution of the cost parameter of 1 m² of living space.

This general conclusion is important, as it allows to estimate the parameters of the closest theoretical distribution based on a statistical sample, and because of this, to determine the statistical characteristics of the key financial indicator of value (1 m² of area of the analyzed premises) with the greatest reliability.

Since the analysis was conducted, first of all, for the general most representative statistical sample throughout Ukraine, we can conclude that this

law of distribution corresponds to the greatest extent to the theoretical one for the specified monetary parameter - the cost of 1 m² of apartments in US dollars.

Below are the density distributions of the cost of 1 m² of apartments on the secondary market of offers in Ukraine as a whole and in the largest cities (Kyiv, Odesa, Kharkiv, Dnipro, Lviv) as of December 2022 when they are approximated by the logarithmic normal distribution law (Fig. 1.5, 1.6). Based on the nature of the distribution and for the convenience of processing statistical data of the real estate market, the sample was logarithmized with a decimal logarithm. The value of the cost per m² were obtained by the inverse logarithm method of the aggregated values of the obtained statistical indicators.

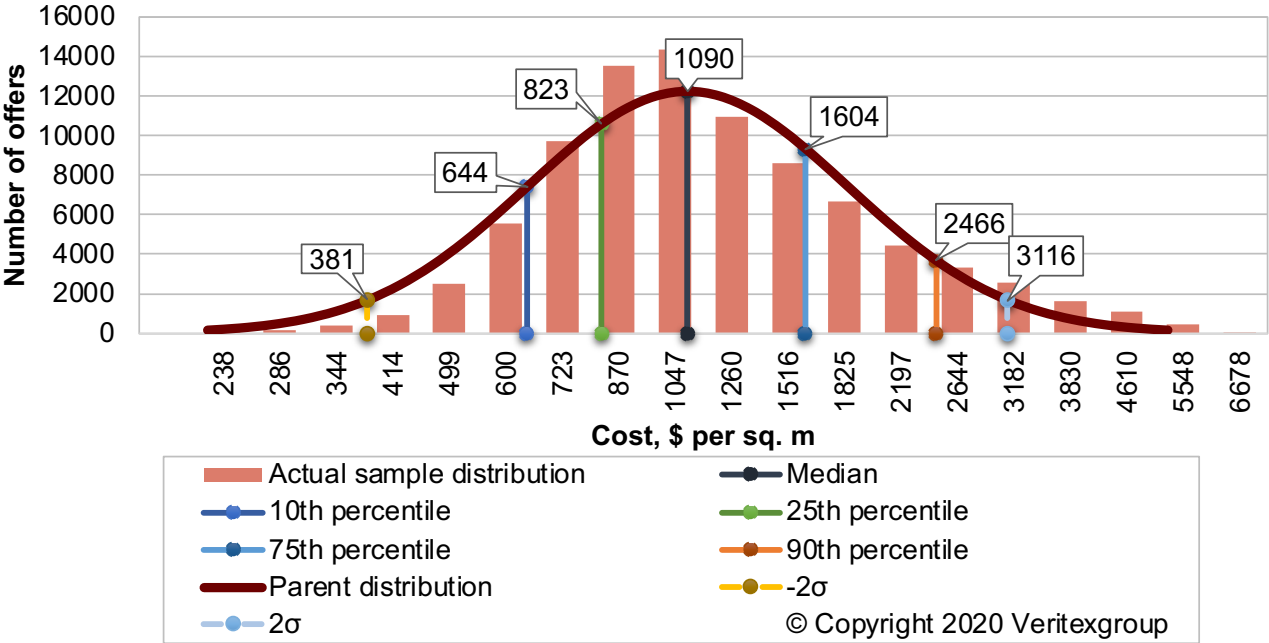


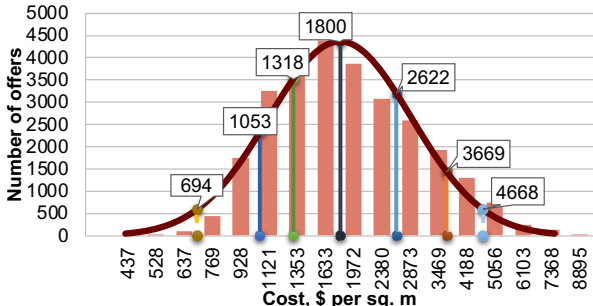
Fig. 1.5. Description of the density distribution of the cost of 1 m² on the secondary apartment market of Ukraine as of December 2022 according to the log-normal distribution law

Thus, based on the obtained results, we can talk about the validity of using such an approach, so all further processing of the primary information database is built on the basis of the definition of the parameters of the log-normal distribution law adopted as a theoretical law for the entire general population of the information database of the distribution of the unit cost square meter of housing.

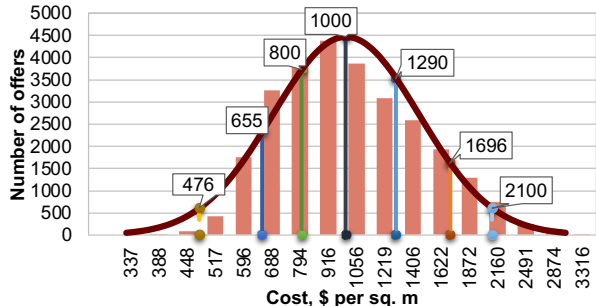
The median prices of apartments in Kyiv, Odesa, Kharkiv, Dnipro and Lviv on the secondary market in December 2022 were \$1,800 per m², \$1,000 per m², \$847 per m², \$909 per m² and \$1,218 per m², respectively. In general, this

indicator for the country is \$1,090 per m², thus, we can observe significant differences in the levels of the average cost for different regions, as well as the degree of their volatility (Table 1.1, Fig. 1.6). At the same time, obtaining only averaged value indicators for each individual city is not sufficient, considering the geographical zoning and zoning of value indicators within the city.

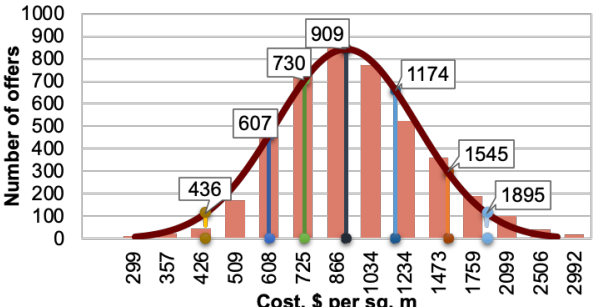
The summary table of the parameters of the distribution of this indicator for all without the exception of regional centers includes not only the average and median values, but also the level of their dispersion and variation, which fully describes the probabilistic -statistical parameters of these distributions (Table 1.1). This table shows the data for the values "mean plus and minus 2 σ", which corresponds to the limits of 95.46% of the corresponding distribution.



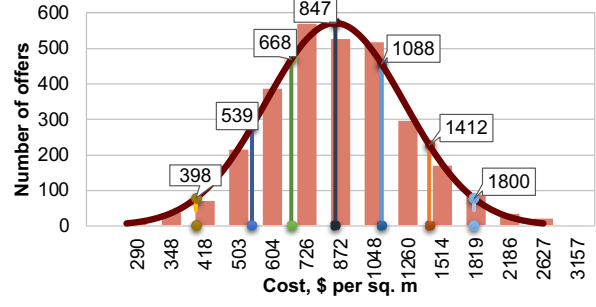
Kyiv. Cost: \$ per m²



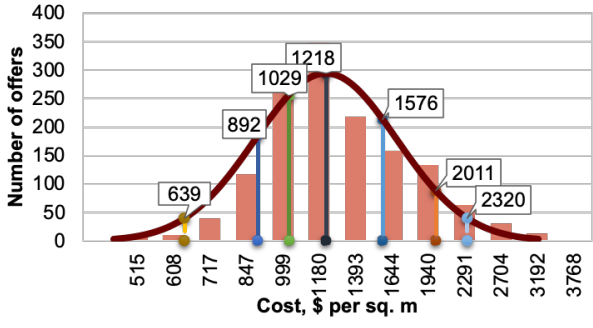
Odesa. Cost: \$ per m²



Dnipro. Cost: \$ per m²



Kharkiv. Cost: \$ per m²



Lviv. Cost: \$ per m²



Fig. 1.6. Description of the density of the distribution of the cost of 1 m² of apartments on the secondary market of the largest cities of Ukraine as of December 2022 by the log-normal distribution law

Table 1.1. Parameters of cost distribution 1 m² of secondary apartment market in regional centers of Ukraine as of December 2022

Region	Amount of offers	Median (μ)	Average	S _{lg} (σ)	Coefficient of variations	Lower confidence limit interval	Upper confidence limit interval
Ivano-Frankivsk	901	2,88	778,10	2,87	0,12	0,18	440,71
Vinnitsia	2243	2,97	967,52	2,97	0,10	0,16	586,41
Dnipro	4381	2,96	1005,45	2,97	0,16	0,25	435,86
Zhytomyr	217	2,91	800,89	2,89	0,12	0,18	462,04
Zaporizhzhia	864	2,81	682,88	2,81	0,14	0,21	349,47
Kyiv	27673	3,26	2130,36	3,28	0,21	0,32	694,16
Kropyvnytskyi	345	2,83	703,80	2,83	0,12	0,18	387,68
Lutsk	64	2,86	754,01	2,86	0,13	0,20	402,91
Lviv	1433	3,09	1353,56	3,11	0,14	0,21	639,05
Mykolaiv	164	2,84	719,43	2,84	0,13	0,20	377,83
Odesa	29082	3,00	1104,21	3,01	0,16	0,25	476,08
Poltava	1348	2,93	900,72	2,94	0,13	0,19	480,52
Rivne	630	2,91	849,40	2,91	0,12	0,18	476,40
Sumy	118	2,74	597,72	2,75	0,15	0,23	277,49
Ternopil	1124	2,91	832,83	2,91	0,11	0,16	505,07
Uzhhorod	315	2,96	986,61	2,97	0,13	0,20	510,32
Kharkiv	2939	2,93	926,61	2,94	0,16	0,25	398,26
Kherson	832	2,84	725,45	2,84	0,12	0,18	402,24
Khmelnyskyi	1951	2,87	779,86	2,88	0,11	0,16	456,44
Cherkasy	190	2,90	829,37	2,90	0,12	0,19	444,80
Chernivtsi	240	2,94	898,18	2,94	0,11	0,17	518,70
Chernihiv	104	2,81	659,81	2,80	0,13	0,19	363,49

It is important to establish the dependence of the cost per m² from the total area of apartments. Analysis of this ratio for one-, two- and more-room apartments shows that the average cost per m² is quite stable to the total area

of apartments of about 65-70 m². Starting from this level of the total area, there is a significant increase in the cost per m². Below is the dependence of the average cost on the area of the apartments, which is presented in the form of ranges (Fig. 1.7, Fig. 1.8).

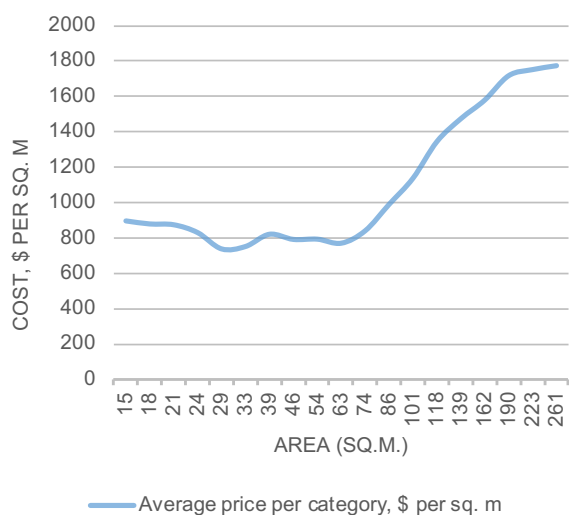


Fig. 1.7. The dependence of the average price on the area of apartments in Ukraine in December 2022

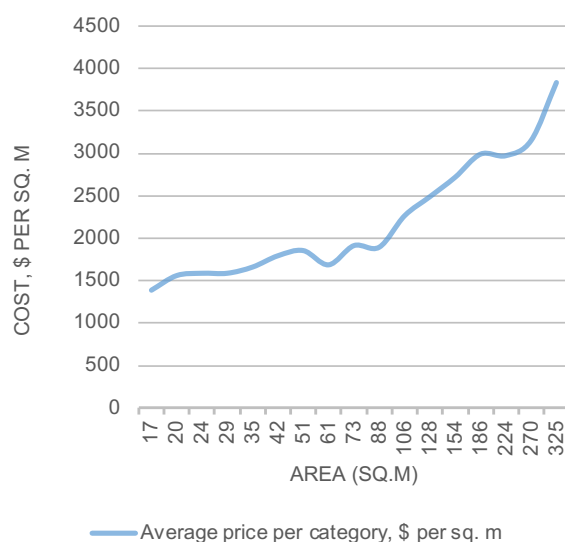


Fig. 1.8. The dependence of the average price on the area of apartments in Kyiv in December 2022

At the same time, for one-room apartments, the dependence of the cost per 1 m² of the apartment is directly proportional, since with the increase of the area, one living room becomes more and more spacious and the value of 1 m² becomes bigger.

Factor analysis is a cornerstone in the processing of large data sets. It allows to predict and simulate the impact of several factors on the target indicator. Without the collection of systematized market information and its in-depth analysis, studying the impact of individual factors is impossible.

Below is an example of a factor analysis of the influence of the floor (table 1.2), type of renovation (table 1.3) and number of rooms (table 1.4) of secondary market residential property on the price per m² in terms of the number of floors of buildings (new and old building funds are distinguished) and location. It is considered that the largest cities and the rest of the territory of Ukraine have different dynamics of local economic processes.

Table 1.2. Change of the median cost of 1 m² depending on the number of floors at the building, location and floor of the apartment

Number of floors at the building	Location	Floor of the apartment	Median cost, \$ per m ²	Absolute difference with the baseline, \$ per m ²	Relative difference from baseline, %
More than 9 floors	Ukraine as a whole	First	436	0	-0,04%
		Average	436	0	0,00%
		Last	394	-42	-9,72%
	The biggest cities *	First	987	-388	-28,20%
		Average	1375	0	0,00%
		Last	1224	-151	-11,00%
	Other cities	First	879	-89	-9,22%
		Average	968	0	0,00%
		Last	885	-83	-8,57%
Less or exactly 9 floors	Ukraine as a whole	First	310	-10	-3,08%
		Average	319	0	0,00%
		Last	272	-48	-14,88%
	The biggest cities *	First	920	-179	-16,26%
		Average	1099	0	0,00%
		Last	967	-132	-12,01%
	Other cities	First	729	-64	-8,03%
		Average	793	0	0,00%
		Last	700	-93	-11,69%

* Kyiv, Dnipro, Lviv, Odessa, Kharkiv

Table 1.3. Change of the median cost of 1 m² depending on the number of floors of the building, location and category of repair of the apartment

Number of floors at the building	Location	Category of repair	Median cost, \$ per m ²	Absolute difference with the baseline, \$ per m ²	Relative difference from baseline, %
More than 9 floors	Ukraine as a whole	Housing condition	815	0	0,00%
		Just built	1042	227	27,89%
		Cosmetic repair	978	163	19,99%
		Eurorenovation	1319	505	61,93%
		Author's project	2000	1185	145,46%
	The biggest cities *	Housing condition	994	0	0,00%
		Just built	1203	209	20,98%
		Cosmetic repair	1000	6	0,59%

		Eurorenovation	1500	506	50,88%	
		Author's project	2243	1249	125,63%	
	Other cities	Housing condition	631	0	0,00%	
		Just built	748	117	18,54%	
		Cosmetic repair	820	189	30,03%	
		Eurorenovation	1049	419	66,39%	
		Author's project	1178	547	86,80%	
	Less or exactly 9 floors	Ukraine as a whole	Housing condition	455	0	0,00%
			Just built	769	315	69,23%
			Cosmetic repair	763	308	67,84%
			Eurorenovation	1016	562	123,59%
			Author's project	1413	959	210,95%
The biggest cities *		Housing condition	902	0	0,00%	
		Just built	841	-61	-6,75%	
		Cosmetic repair	876	-26	-2,90%	
		Eurorenovation	1200	298	32,98%	
		Author's project	2057	1155	127,99%	
Other cities		Housing condition	386	0	0,00%	
		Just built	720	334	86,55%	
	Cosmetic repair	694	308	79,85%		
	Eurorenovation	930	544	141,02%		
	Author's project	1100	714	185,00%		

* Kyiv, Dnipro, Lviv, Odessa, Kharkiv

Table 1.4. Change of the median cost of 1 m² depending on the number of floors of the building, location and number of rooms of the apartment

Number of floors at the building	Location	Number of rooms	Median cost, \$ per m ²	Absolute difference with the baseline, \$ per m ²	Relative difference from baseline, %
More than 9 floors	Ukraine as a whole	1	1202	0	0,00%
		2	1235	33	2,74%
		3	1282	79	6,60%
		4	1592	390	32,44%
		5	1786	583	48,51%
	The biggest cities *	1	1293	0	0,00%
		2	1341	49	3,77%
		3	1381	88	6,80%
		4	1695	403	31,14%
		5	1905	612	47,35%
	Other cities	1	992	0	0,00%
		2	947	-45	-4,50%

		3	888	-104	-10,52%
		4	805	-187	-18,81%
		5	848	-144	-14,55%
Less or exactly 9 floors	Ukraine as a whole	1	955	0	0,00%
		2	875	-80	-8,33%
		3	830	-124	-13,00%
		4	852	-102	-10,70%
		5	998	43	4,55%
	The biggest cities *	1	1083	0	0,00%
		2	1021	-62	-5,76%
		3	978	-105	-9,70%
		4	1011	-72	-6,65%
		5	1068	-15	-1,42%
	Other cities	1	837	0	0,00%
		2	760	-77	-9,21%
		3	700	-137	-16,38%
		4	679	-158	-18,89%
		5	613	-224	-26,79%

* Kyiv, Dnipro, Lviv, Odessa, Kharkiv

Based on the obtained results, it can be stated that the floor of the apartment affects the cost in differently, depending on the location and type of building fund. In new buildings, apartments on the top floor usually have the best panoramic views. Apartments on the top floor in buildings of the old stock do not have such an advantage, so their value is reduced. Therefore, in new buildings, the last floor is more expensive than the first, and vice versa - for the old fund. The cost of the first and last floors for the old fund of the largest cities are in approximate parity.

Analysis of the influence of the repair class on the cost of housing makes it possible to conclude that the difference in price between a suitable housing condition and cosmetic repair is absent in major cities, regardless of the type of building stock. In turn, the presence of European renovation or an elite level of housing condition significantly increases its value.

An essential element of the analysis of the original information base of the real estate market is the determination of the time dynamics of its development. The information provided in Fig. 1.9, 1.10, 1.11 demonstrates the dynamics of a slight increase in the cost of housing until 2022. This trend persisted even when a full-scale war broke out on the territory of Ukraine, until the end of the 1st quarter of 2022. Note that it was in April that there was a sharp increase in the upper limit of the value, which was followed by a drop in

this indicator. In May, we observed a significant decline in the general picture, nevertheless, by September, the market returned to a stable state.

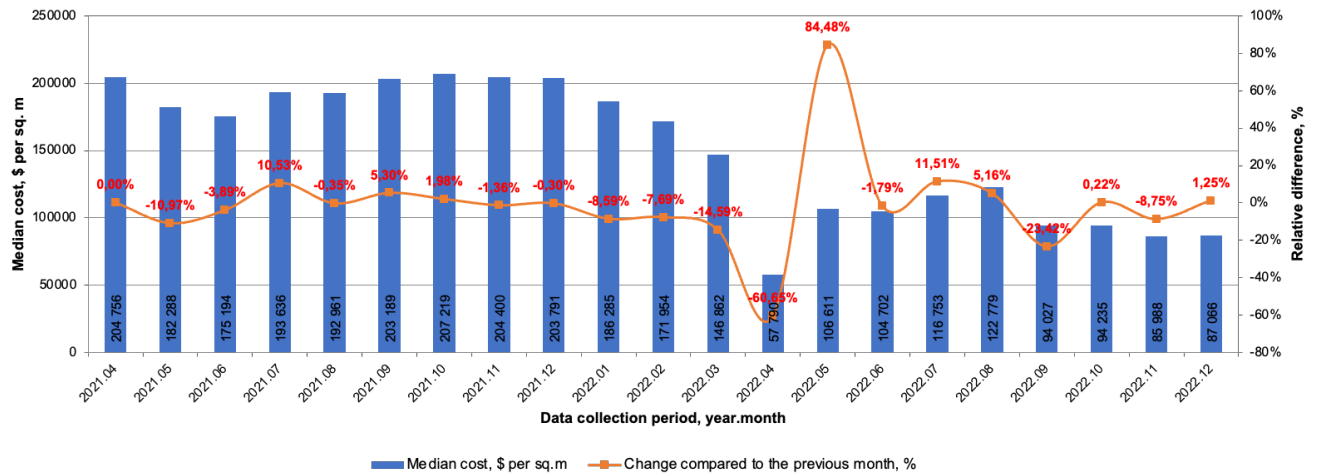


Fig. 1.9. Evolution of the median cost per m² on the secondary apartment market in Ukraine, 2021-2022

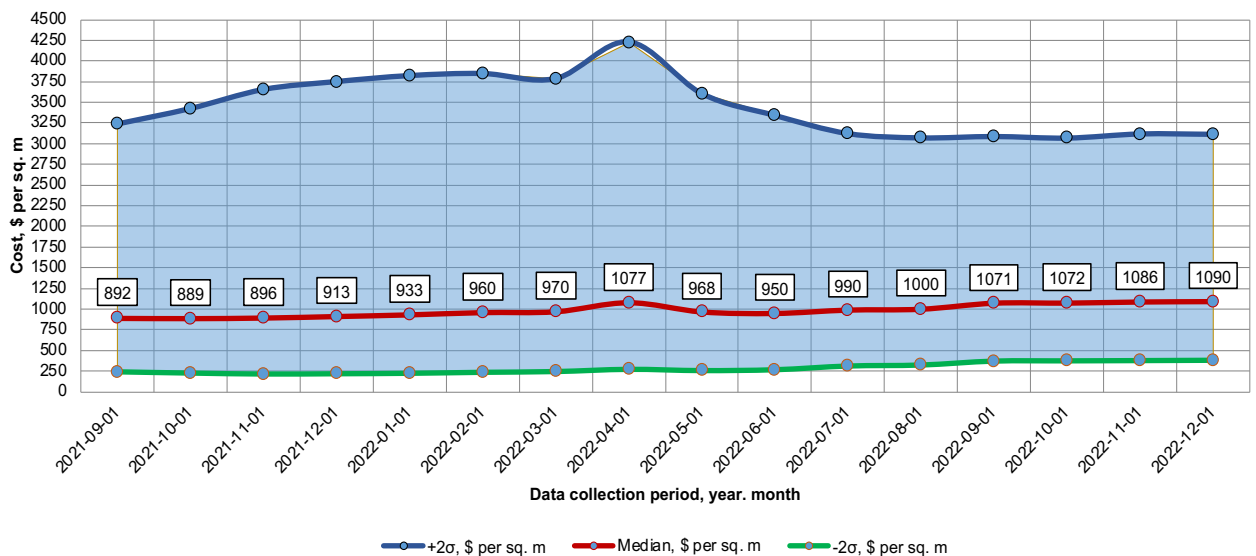
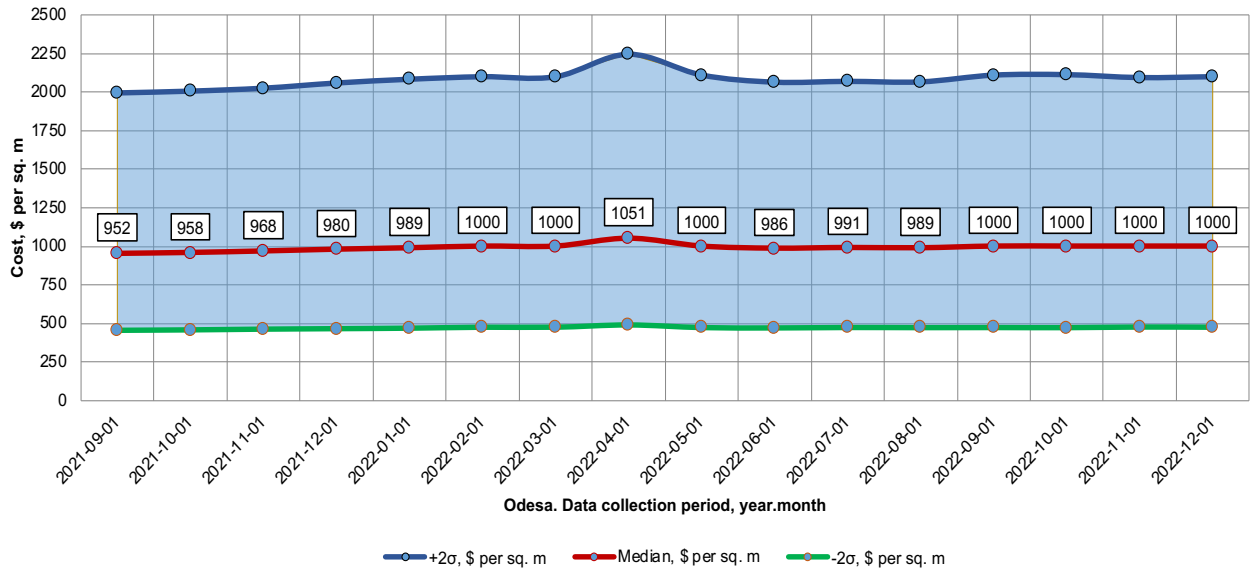
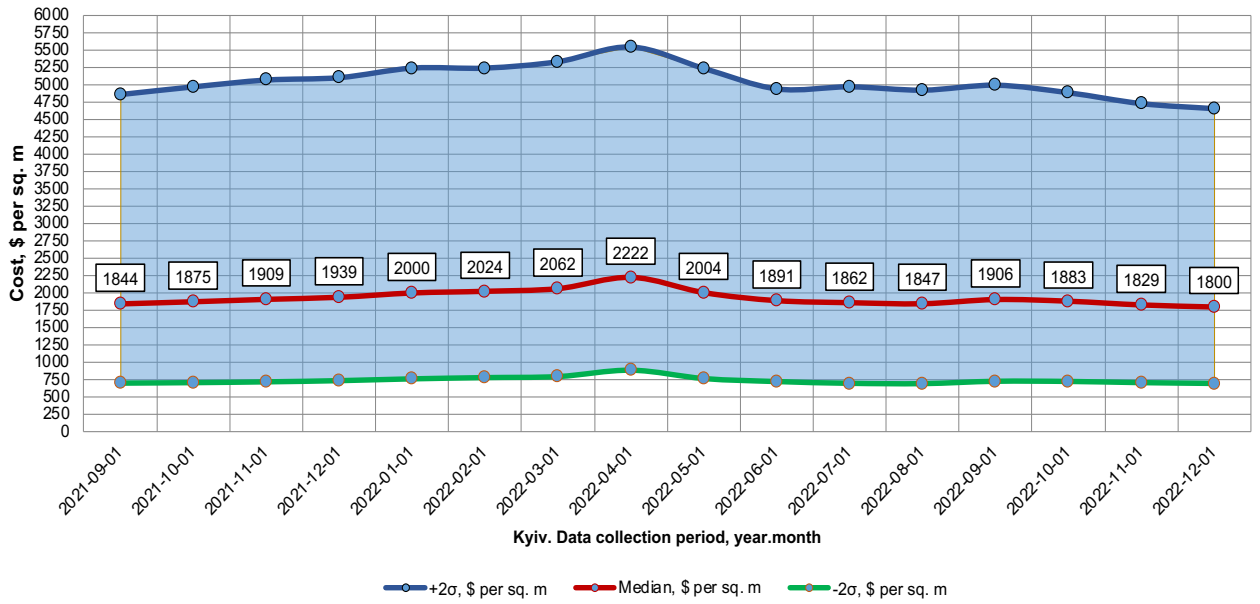
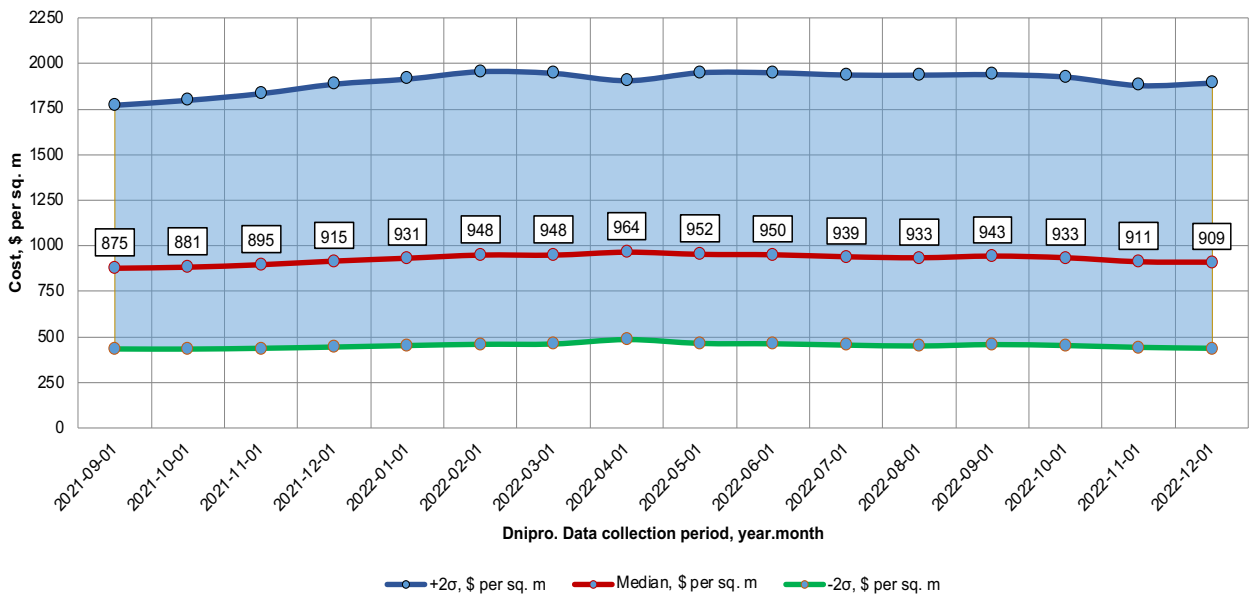
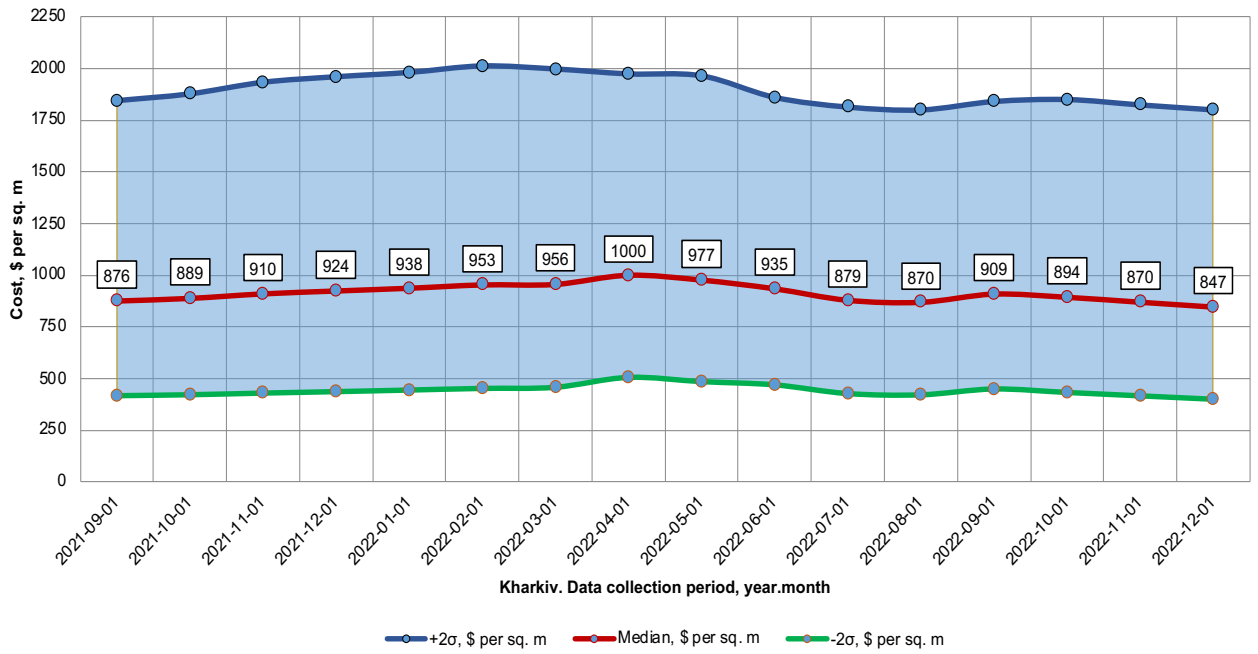


Fig. 1.10. Evolution of the median and marginal cost per m² on the secondary apartment market in Ukraine, 2021-2022





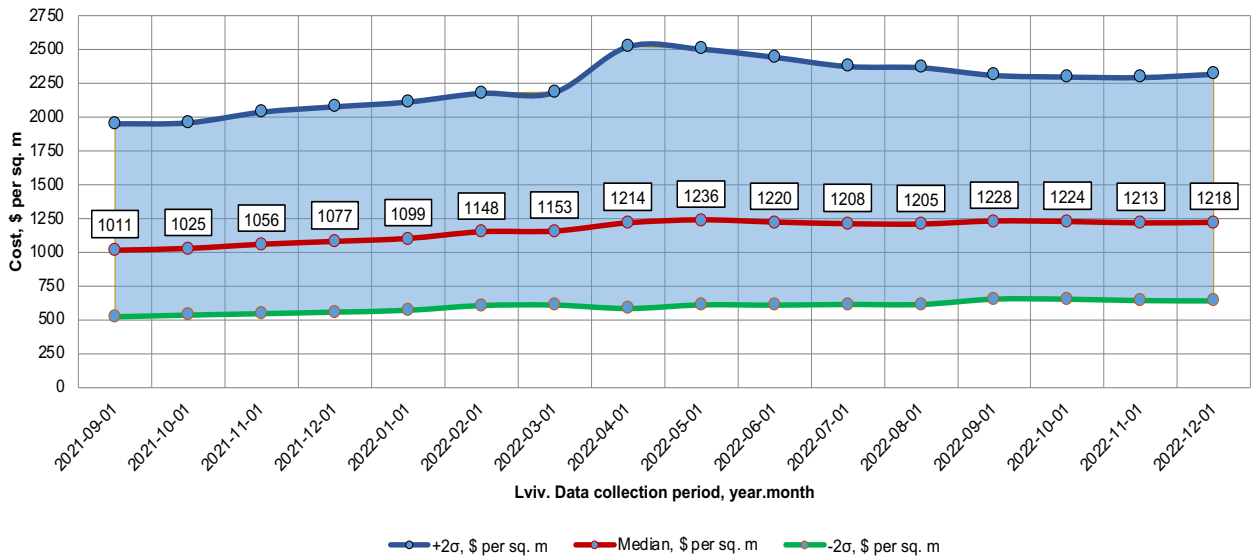


Fig. 1.11. Evolution of the median cost per m^2 on the secondary apartment market in the largest cities, 2021-2022

In contrast to the situation in 2020-2021, when during the pandemic the coefficient of variation of the cost of 1 m^2 of housing remained quite stable with a slight downward trend (Fig. 1.12, Fig. 1.13), the war had a much more significant effect on it, as a result of which we can observe noticeable fluctuations and a decrease that began in January 2022 and continues until now.

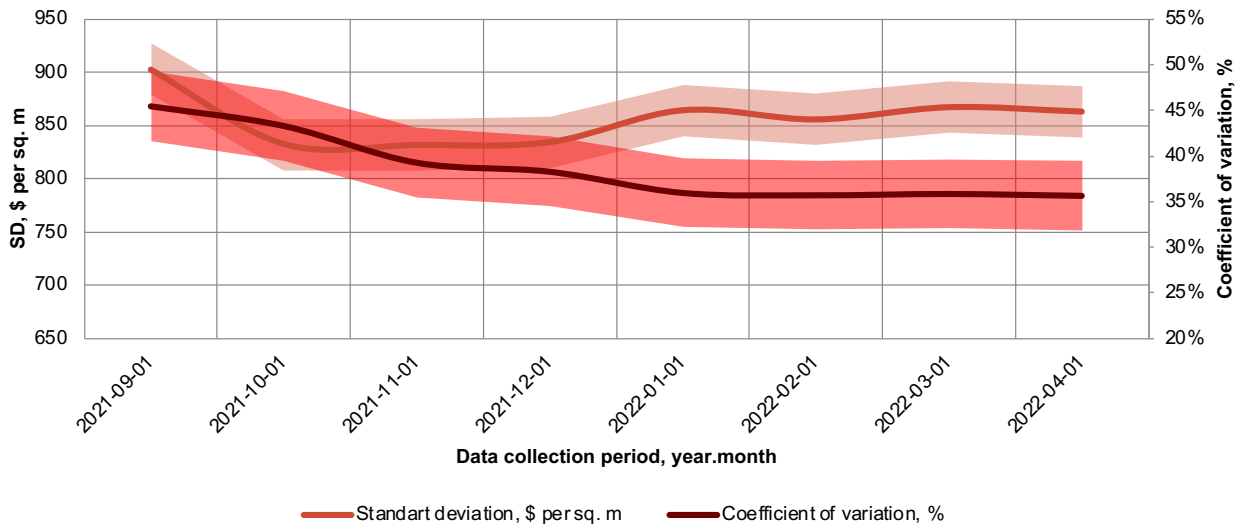
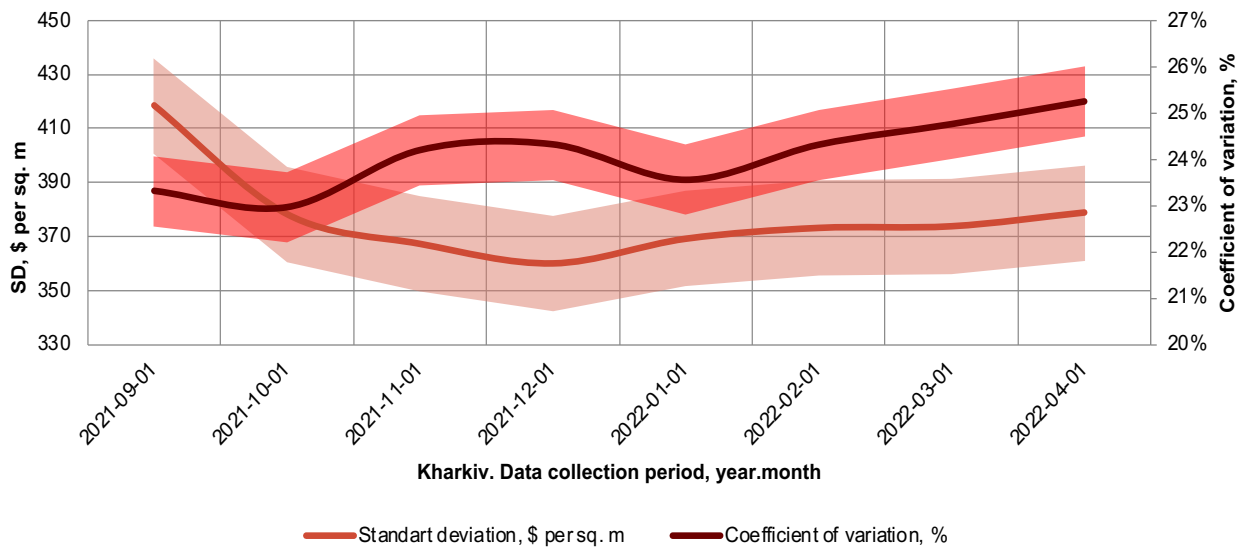
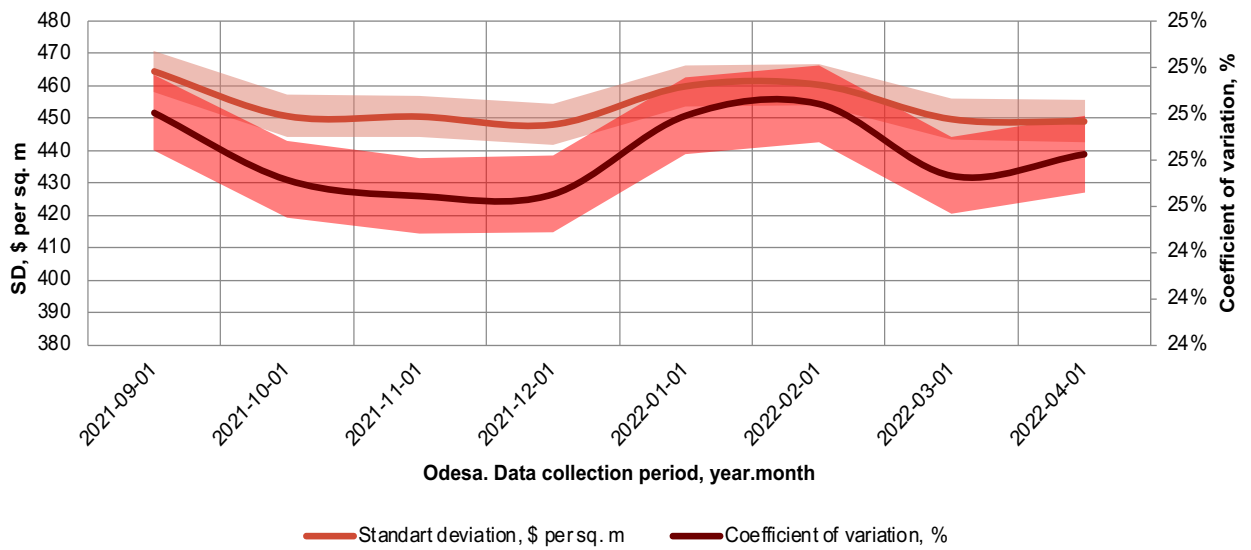
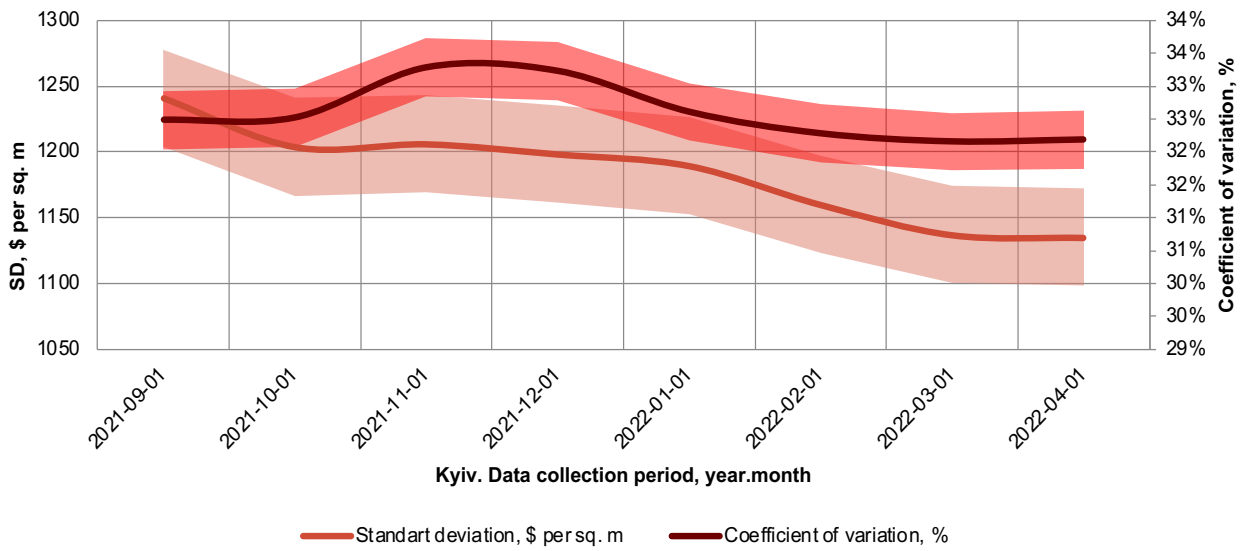


Fig. 1.12. Evolution of dispersion and coefficient of variation of the cost of 1 m^2 on the secondary housing market in Ukraine, 2021-2022



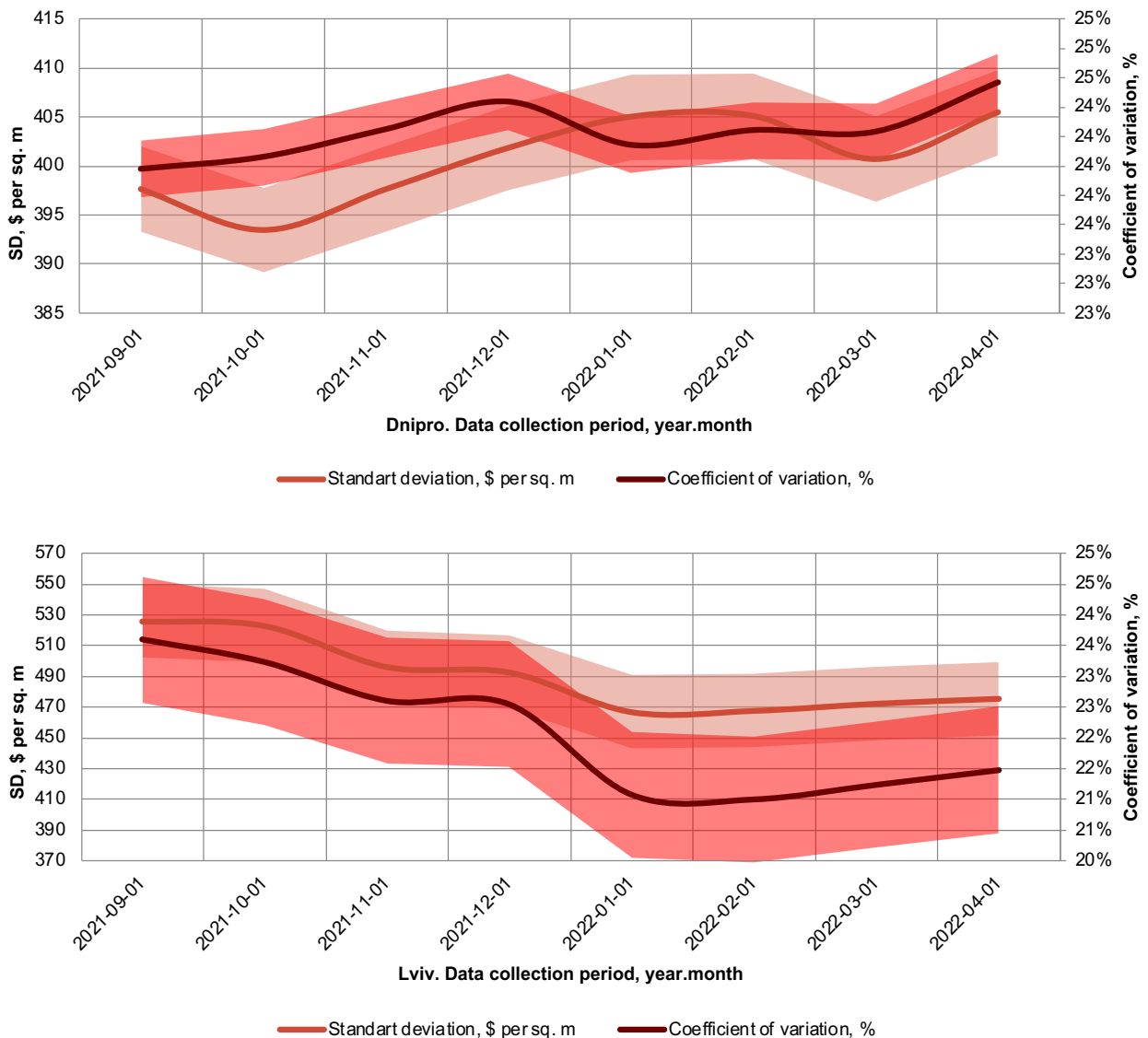


Fig. 1.13. Evolution of dispersion and coefficient of variation of the cost of 1 m² on the secondary housing market in the largest cities, 2021-2022

The information base of the real estate market is constantly replenished and updated, which allows expanding its analytics using modern methods of mathematical and statistical processing of results and obtaining the most reasonable and reliable parameters of this market and its evolution with the determination of the influence of a wide range of individual pricing factors.

- 2022 was very unpredictable for objective reasons, one way or another connected with the start of a full-scale war, so the market reaction was also difficult to predict. There is a rather sharp increase in April, which can be attributed to increased demand due to the influx of refugees, which provoked

an increase in prices. However, in the following period, this abnormal growth leveled off, the market returned to relatively stable growth.

- Although it is also worth noting that this trend in 2022 is not characteristic of all cities. Yes, Kharkiv is a front-line city that suffers quite a lot from shelling, so the market reacted accordingly by lowering prices and demand. It is obvious that the cost of square meters has increased significantly in the western regions (this can be clearly seen on the graph that describes the dynamics of prices in Lviv, but similar trends apply to Ivano-Frankivsk and Volyn). Such a situation is quite predictable, because this is where most of the temporarily displaced and evacuated persons were directed. A similar picture was observed in Kyiv after the liberation of the region and the cessation of the offensive on the capital.

- Some regions are not very far from the zones of active hostilities, but still the prices have increased in the Dnipropetrovsk region. Again, this is connected with immigrants. People chose relatively safe regions, but which are closer to their native homes. The number of offers decreased, which provoked an increase in prices.

- Such cities as Odesa have not undergone significant changes, because this direction was popular even before the war. The smallest price increase affected the frontline regions. Yes, in Kharkiv the prices have fallen noticeably, we can make assumptions.

Thus, the study of the general evolution of real estate prices for June 2019 - October 2022 shows, on average, a growing trend, which is stimulated by an increasing demand for residential square meters. As an anomalous phenomenon from the point of view of the general dynamics that have developed in the real estate market over the past 12 years, the behavior of prices during periods of crises caused by extraordinary events and conditions (pandemic and war) observed in 2020 and in the current year 2022 is of particular interest.

2. INFORMATION AND ANALYTICAL UNIT OF THE LAND MARKET

The information and analytical unit of the market of land plots is divided into three subdivisions according to their purpose:

- Land plots for residential and public buildings;
- Agricultural plots of land;
- Land plots for industrial development.

As of the end of December of 2022, the information base of the land market covers about 32,000 unique offers, where 58% are residential plots, 37% - agricultural plots, and 5% - industrial plots. The total value of the land market currently is 4.12 billion dollars. USA. (Fig. 2.1).

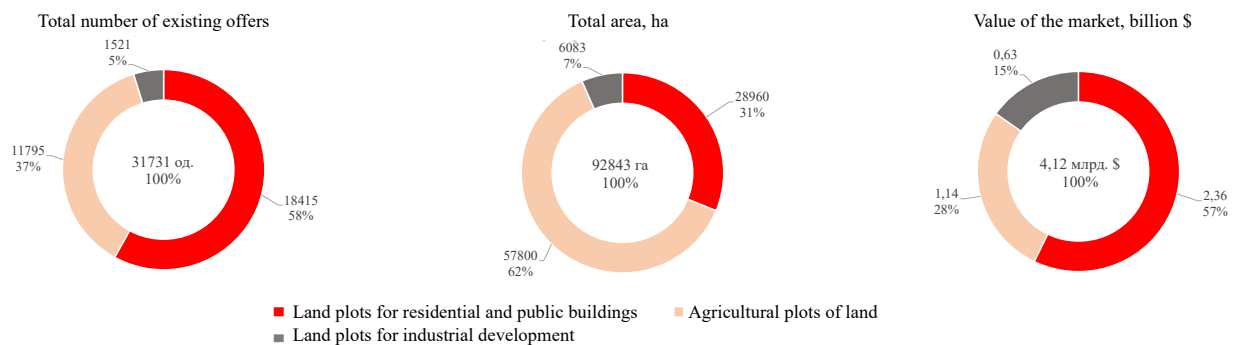


Fig. 2.1. Volume of the land market in Ukraine as of December 2022

Quarterly indicators of the volume of the land market in Ukraine for the period 2021-2022 give a dynamic description of the general picture, considering the influence of various factors that restrained or, on the contrary, revived market activity (Fig. 2.2, 2.3). With the opening of the agricultural land market from July 1, 2021, a rapid growth of this category of land plots in the general information base of the land market was expected. The analysis of the mentioned indicators confirms this, showing a rapid growth in the third quarter of 2021. In the second quarter of 2022, the market largely reflected a full-scale war: which caused a shock situation and a significant drop, both in terms of quantitative and value results. Nevertheless, the third quarter has shown a tendency to recovery.

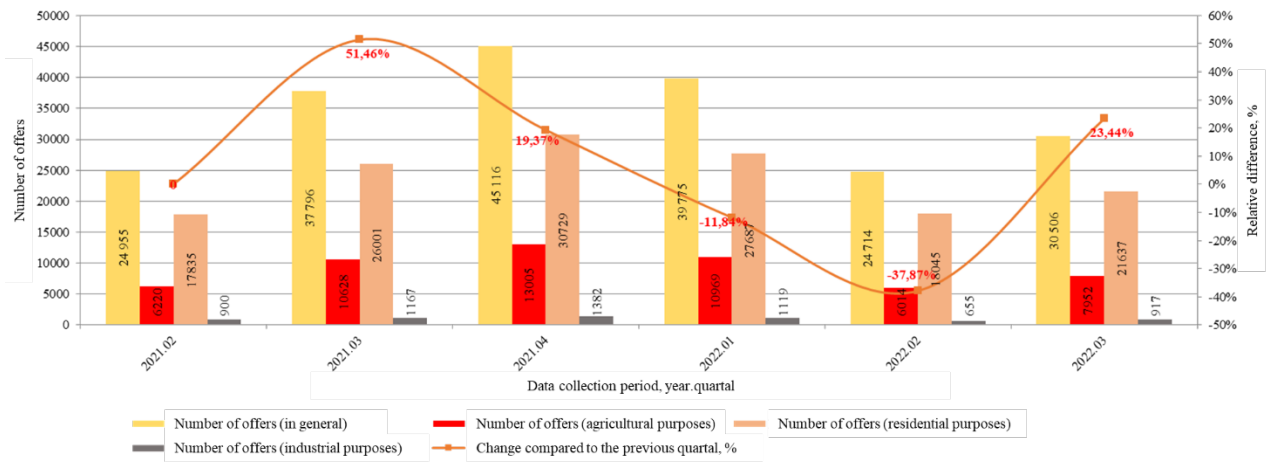


Fig. 2.2. Evolution of the number of offers on the land market in Ukraine, 2021-2022

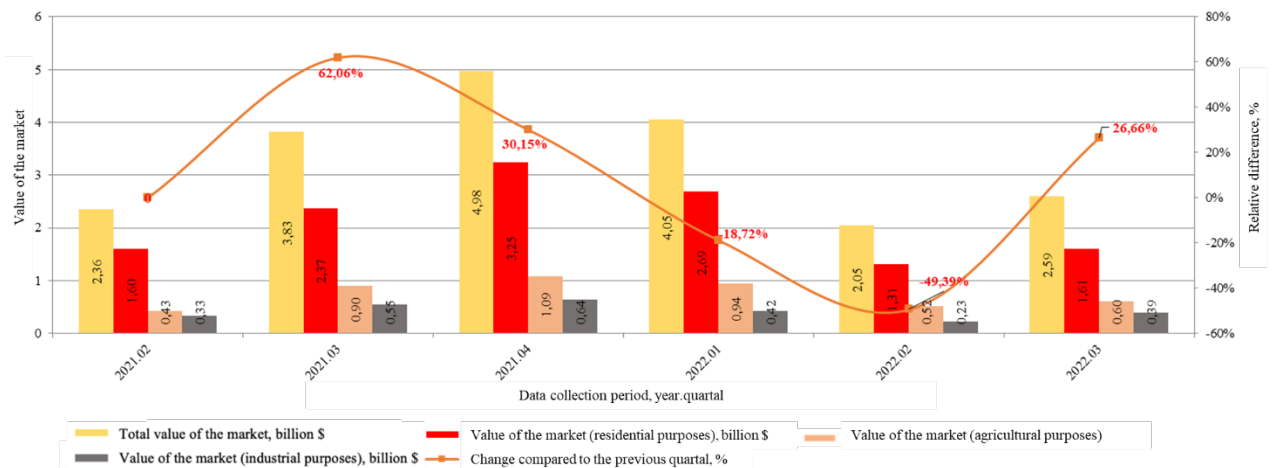


Fig. 2.3. Evolution of the value of the land market in Ukraine, 2021-2022

The conducted analysis showed that the distribution of prices on the land market is also subject to the lognormal distribution law, which was adopted as the theoretical distribution law (Fig. 2.4, 2.5). As a unit of measurement of the area of land plots, one hectare is accepted as the most widely used.

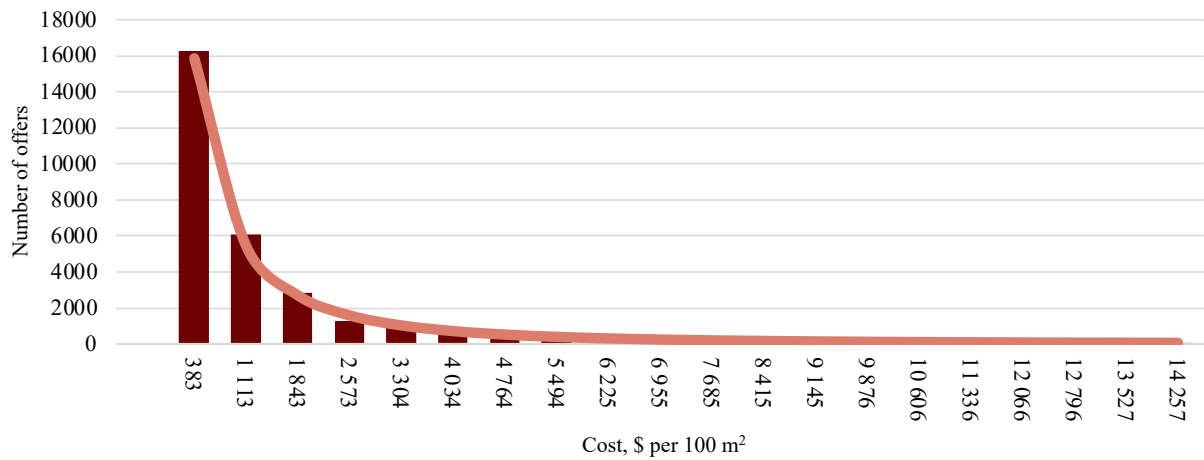


Fig. 2.4. Density distribution cost of 1 m² on the land market of Ukraine as of December 2022

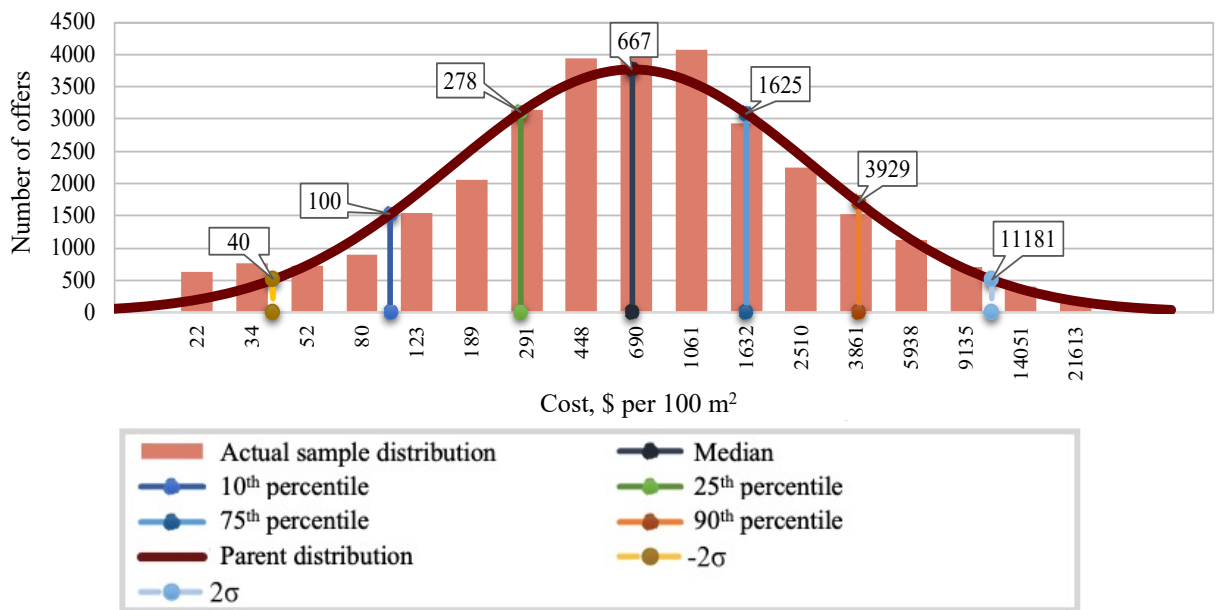
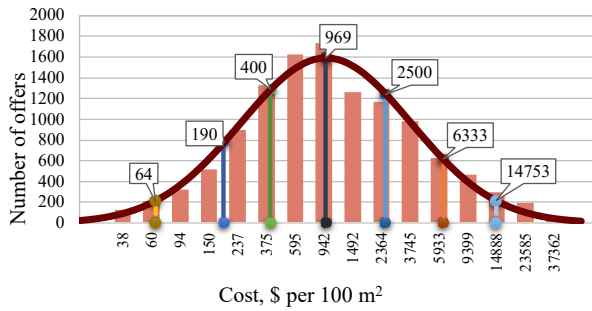
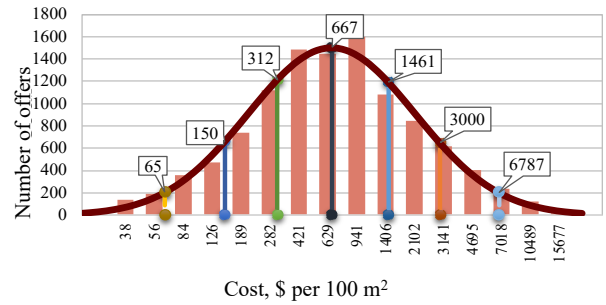


Fig. 2.5. Description of the density distribution of the cost of 1 m² on the land market of Ukraine as of December 2022 according to the log-normal distribution law

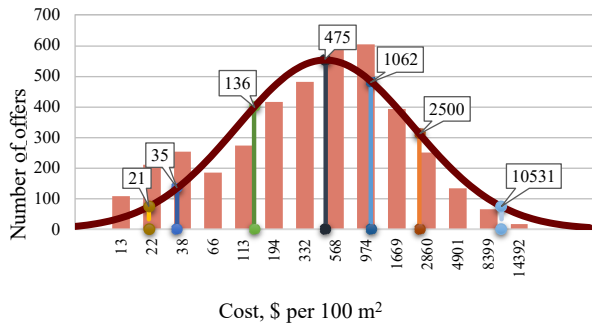
Checking the validity of this conclusion for a large number of statistical samples for separate regions and different time intervals confirmed its reasonableness (Fig. 2.6).



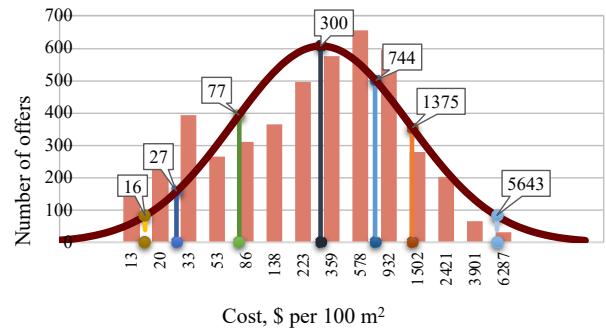
Land plots for residential buildings, central agglomerations. Cost: \$ per 100 m²



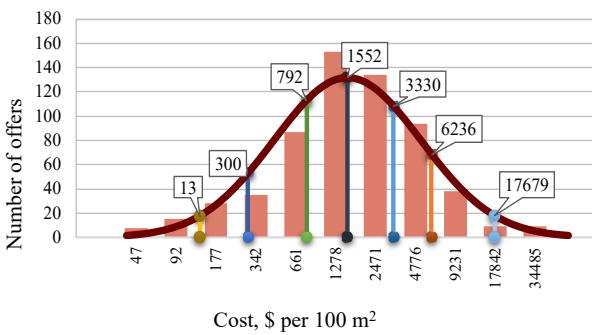
Land plots for residential buildings, periphery. Cost: \$ per 100 m²



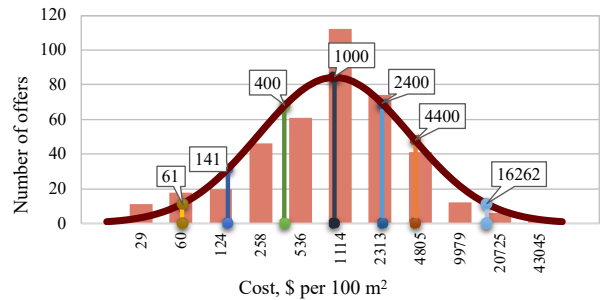
Agricultural plots of land, central agglomerations. Cost: \$ per 100 m²



Agricultural plots of land, periphery. Cost: \$ per 100 m²



Land plots for industrial development, central agglomerations. Cost: \$ per 100 m²



Land plots for industrial development, periphery. Cost: \$ per 100 m²

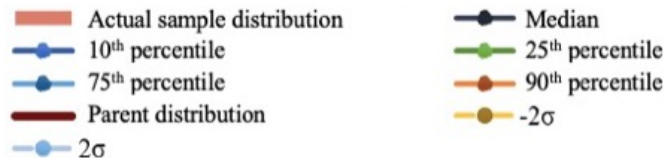


Fig. 2.6. Description of the density of the distribution of the cost of 100 m² land on the market of Ukraine depending on the type of land use and geographical cluster as of December 2022 according to the log-normal distribution law

The consolidated table of land value distribution parameters for all regions without exception includes not only the average and median values, but also the level of their dispersion and variation, which fully describes the probabilistic-statistical parameters of these distributions (tables 2.1 - 2.3). These tables show data for the "mean plus and minus 2 σ " values, which correspond to the limits of 95.46% of the corresponding distribution.

Given in the table 2.1 - 2.3 and on Fig. 2.7 - 2.10 data indicate significant differences in both the levels of the average cost for different regions (reaches 3-4 times), and the degree of their volatility.

The application of the k-means statistical method proved to be the most effective for determining value clusters within individual cities and regions.

Table 2.1. Parameters of cost distribution 100 m² of land market (land plots for residential and public buildings) in regional centers of Ukraine as of December 2022

Region	Amount of offers	Median (μ)	Average	$S_{lg}(\sigma)$	Coefficient of variations	Lower confidence limit interval	Upper confidence limit interval
Odesa region	2083	1562,50	5557,49	0,68	1,37	68,93	35418,86
Vinnitsia region	1286	1000,00	2182,71	0,54	0,99	81,48	12272,28
Ivano-Frankivsk region	1029	1000,00	1710,09	0,55	1,01	78,81	12688,26
Luhansk region	6	1000,00	1680,25	0,42	0,71	143,51	6968,31
Kyiv region	4913	900,00	2074,54	0,58	1,08	62,10	13042,72
Lviv region	1922	900,00	1568,96	0,48	0,84	97,97	8267,81
Transcarpathian region	742	881,14	1465,29	0,44	0,76	114,33	6791,25
Chernivtsi region	369	833,33	1378,81	0,54	0,97	70,32	9875,51
Dnipropetrovsk region	1158	819,09	1705,73	0,56	1,02	63,20	10615,02
Ternopil region	500	800,00	1438,36	0,44	0,74	107,93	5929,88
Zaporizhzhia region	160	702,29	877,24	0,44	0,76	90,65	5440,92
Mykolaiv region	142	699,50	1227,18	0,46	0,79	83,96	5827,92
Donetsk region	32	683,13	964,76	0,57	1,06	48,86	9551,99
Khmelnyskyi region	608	650,00	1234,04	0,48	0,83	71,95	5872,15

Kharkiv region	244	583,33	1367,85	0,52	0,94	52,44	6488,46
Rivne region	709	537,50	1011,60	0,47	0,81	62,73	4605,37
Volyn region	662	524,40	783,69	0,44	0,75	68,53	4012,83
Poltava	621	500,00	939,56	0,48	0,85	53,74	4652,32
Zhytomyr region	573	500,00	791,45	0,44	0,76	64,81	3857,69
Cherkasy region	426	496,10	1053,85	0,51	0,92	45,80	5373,29
Kirovohrad region	236	400,00	764,47	0,53	0,94	35,45	4513,79
Sumy region	159	318,18	653,28	0,55	0,99	25,48	3974,04
Chernihiv region	264	304,96	490,70	0,44	0,74	41,01	2267,98

Table 2.2. Parameters of cost distribution 100 m² of land market (agricultural plots of land;) in regional centers of Ukraine as of December 2022

Region	Amount of offers	Median (μ)	Average	S_{lg} (σ)	Coefficient of variations	Lower confidence limit interval	Upper confidence limit interval
Chernivtsi region	13	2093,02	3045,48	0,58	1,09	142,18	30810,64
Lviv region	101	2000,00	2679,57	0,53	0,95	177,08	22588,62
Ivano-Frankivsk region	34	1644,69	2374,30	0,64	1,25	87,34	30970,34
Kyiv region	316	1500,00	2204,05	0,51	0,89	146,78	15328,94
Odesa region	75	1500,00	2967,31	0,56	1,02	114,89	19584,71
Vinnitsia region	18	1446,48	2688,30	0,67	1,35	65,81	31791,71
Chernihiv region	5	1400,00	1533,13	0,98	2,87	15,29	128146,82
Transcarpathian region	20	1229,79	1823,80	0,37	0,61	221,98	6813,26
Kirovohrad region	8	1207,61	1578,65	0,39	0,66	197,19	7395,65
Volyn region	33	1200,00	1361,88	0,59	1,11	79,56	18100,43
Dnipropetrovsk region	51	1000,00	1826,45	0,51	0,89	97,87	10221,13
Ternopil region	15	1000,00	1304,68	0,46	0,80	118,00	8474,28
Rivne region	41	961,54	1717,35	0,55	1,01	75,86	12187,19
Poltava	10	915,63	1166,64	0,66	1,32	43,43	19308,19
Khmelnyskyi region	16	816,49	1451,96	0,38	0,63	142,72	4671,02
Cherkasy region	22	787,39	1436,94	0,62	1,20	44,56	13912,83

Mykolaiv region	5	766,67	656,88	0,26	0,42	228,99	2566,90
Zhytomyr region	20	485,78	932,86	0,43	0,72	68,75	3432,29
Kharkiv region	1	403,00	403,00	-	-	-	-
Zaporizhzhia region	3	269,23	778,23	0,65	1,27	13,82	5246,76
Sumy region	2	166,08	167,31	0,08	0,11	117,85	234,06
Donetsk region	1	18,18	18,18	-	-	-	-

Table 2.3. Parameters of cost distribution 100 m² of land market (land plots for industrial development) in regional centers of Ukraine as of December 2022

Region	Amount of offers	Median (μ)	Average	S_{lg} (σ)	Coefficient of variations	Lower confidence limit interval	Upper confidence limit interval
Ivano-Frankivsk region	2	564,08	607,58	0,24	0,38	187,06	1700,97
Lviv region	414	555,67	1533,17	0,66	1,31	26,76	11538,18
Kherson region	363	550,00	844,41	0,52	0,93	49,99	6051,29
Transcarpathian region	362	500,00	819,04	0,54	0,97	42,28	5913,46
Odesa region	1626	500,00	1174,34	0,59	1,12	32,23	7756,56
Kyiv region	184	451,07	675,39	0,56	1,02	35,06	5803,67
Vinnitsia region	163	450,00	637,33	0,47	0,81	51,82	3907,45
Chernivtsi region	221	383,33	657,04	0,47	0,81	44,38	3311,06
Ternopil region	166	363,02	462,85	0,45	0,78	45,04	2926,24
Rivne region	344	300,00	494,35	0,51	0,89	29,02	3101,29
Khmelnyskyi region	26	250,00	421,30	0,53	0,95	21,83	2862,74
Volyn region	215	250,00	468,46	0,51	0,91	23,86	2619,63
Zhytomyr region	54	239,56	370,92	0,59	1,13	15,24	3766,89
Mykolaiv region	64	202,03	433,36	0,62	1,18	11,89	3431,18
Kharkiv region	284	177,48	412,08	0,60	1,14	11,12	2833,31
Zaporizhzhia region	175	160,55	291,66	0,61	1,18	9,51	2710,33
Poltava	196	153,05	357,83	0,59	1,10	10,26	2283,67

Chernihiv region	304	129,26	494,64	0,69	1,39	5,49	3041,46
Cherkasy region	2	123,32	125,69	0,12	0,18	70,86	214,60
Dnipropetrovsk region	63	90,36	251,08	0,63	1,22	4,96	1645,61
Luhansk region	81	44,17	214,11	0,57	1,05	3,21	608,52
Donetsk region	9	36,50	568,69	0,87	2,15	0,68	1970,01

The dependence of the cost of 100 m² of land on the total size of the plot for residential or industrial development and agricultural plots is shown in fig. 2.7 - 2.10.

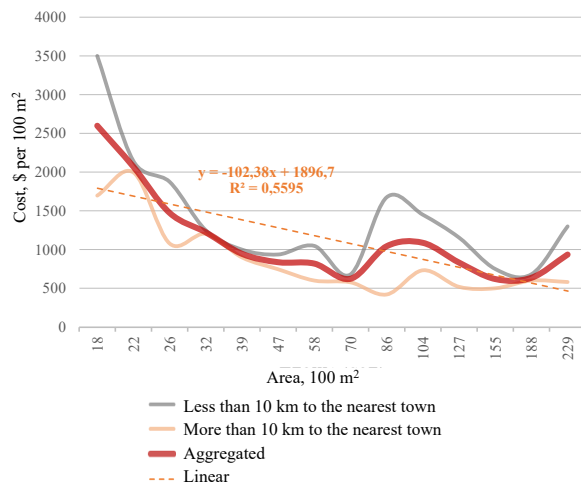


Fig. 2.7. Dependence of the value of 100 m² of residential land holdings on their total area (Central agglomerations)

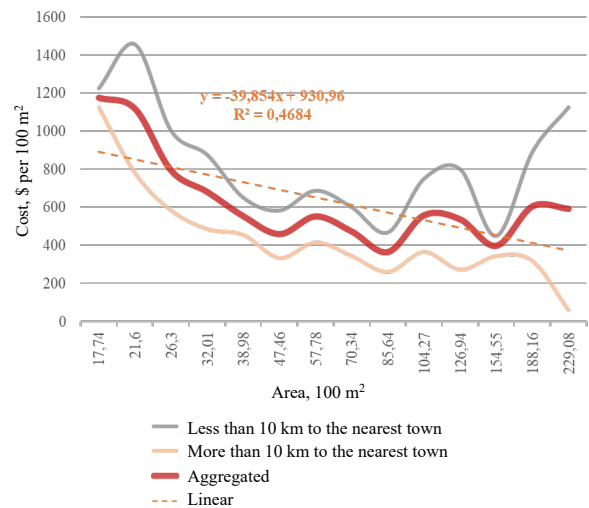


Fig. 2.8. Dependence of the value of 100 m² of residential land holdings on their total area (Periphery)

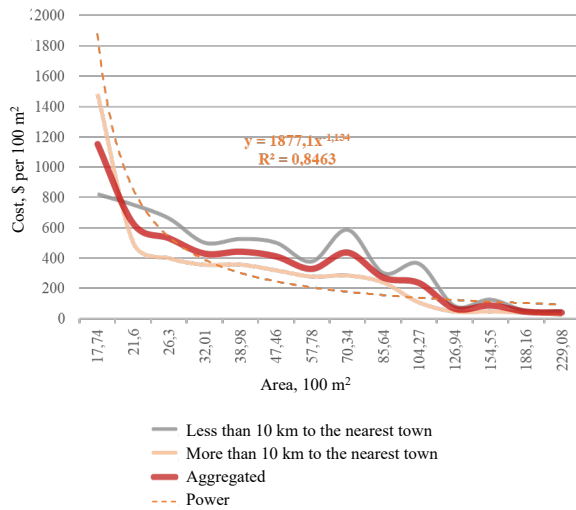


Fig. 2.9. Dependence of the value of 100 m² of agricultural land plots on their total area

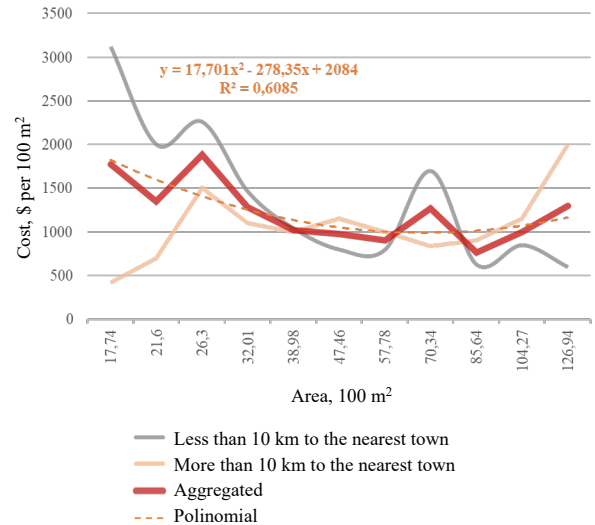


Fig. 2.10. Dependence of the value of 100 m² of industrial land holdings on their total area

In a generalized form, this information is presented in table 2.4, where the median cost of 100 m² is provided depending on the category of land use, distance from the nearest cities and regions of location. The sizes of land plots are conditionally divided into up to 2500 m² and more than 2500 m², since in Ukraine most often no more than 2500 m² are allocated for one household.

Table 2.4. Dependence of the cost of 100 m² of land on the category of land use, region, distance to the nearest city and the size of the plot

Category of land use	Region	Distance to the nearest city	Plot size	Median cost, \$/100m ²	Absolute difference from the baseline, \$/100m ²	Relative difference from baseline, %
Land plots for residential and public buildings	Periphery	From 10 to 50 km	In general	334,35	-	-
			More than 2500 m ²	339,65	5,29	2%
			Up to 2500 m ²	400	65,65	20%
		Up to 10 km	In general	600,00	-	-
			More than 2500 m ²	800	200,00	33%
			Up to 2500 m ²	909,09	309,09	52%
	Central agglomerations *	From 10 to 50 km	In general	500,00	-	-
			More than 2500 m ²	532,77	32,77	7%
			Up to 2500 m ²	726,67	226,67	45%

		Up to 10 km	In general	1022,11	-	-
			More than 2500 m ²	1000	-22,11	-2%
			Up to 2500 m ²	1302,08	279,975	27%
Industrial plots of land	Periphery	From 10 to 50 km	In general	433	-	-
			More than 2500 m ²	433,33	0,33	0%
			Up to 2500 m ²	1060,60	627,6	145%
		Up to 10 km	In general	1003	-	-
			More than 2500 m ²	990,05	-12,95	-1%
			Up to 2500 m ²	2352,94	1349,94	135%
	Central agglomerations *	From 10 to 50 km	In general	1183	-	-
			More than 2500 m ²	1023,56	-159,44	-13%
			Up to 2500 m ²	1450,00	267	23%
		Up to 10 km	In general	1500	-	-
			More than 2500 m ²	1300	-200	-13%
			Up to 2500 m ²	3750	2250	150%
Agricultural plots of land	Periphery	From 10 to 50 km	In general	69,34	-	-
			More than 2500 m ²	76	6,665	10%
			Up to 2500 m ²	375	305,665	441%
		Up to 10 km	In general	137,88	-	-
			More than 2500 m ²	234,31	96,435	70%
			Up to 2500 m ²	600,00	462,125	335%
	Central agglomerations *	From 10 to 50 km	In general	204,17	-	-
			More than 2500 m ²	190	-14,165	-7%
			Up to 2500 m ²	563,92	359,755	176%
		Up to 10 km	In general	350,00	-	-
			More than 2500 m ²	350,14	0,135	0%
			Up to 2500 m ²	870,00	520	149%

* Kyiv region, Odesa region, Lviv region, Kharkiv region, Dnipropetrovsk region

An essential element of the analysis of the original information base of the real estate market is the determination of the time dynamics of its development. Provided in Fig. 2.11-2.13, the information shows the dynamics of the fall in the value of land until the middle of 2021, after which there was a relative stabilization of the median price with minor fluctuations

in the overall picture (up to 14%). This tendency was preserved even during the unfolding of the war on the territory of Ukraine. However, there was a sharp drop in March, after which the indicator recovered to pre-war levels and returned to a stable state with a gradual upward trend in recent months.

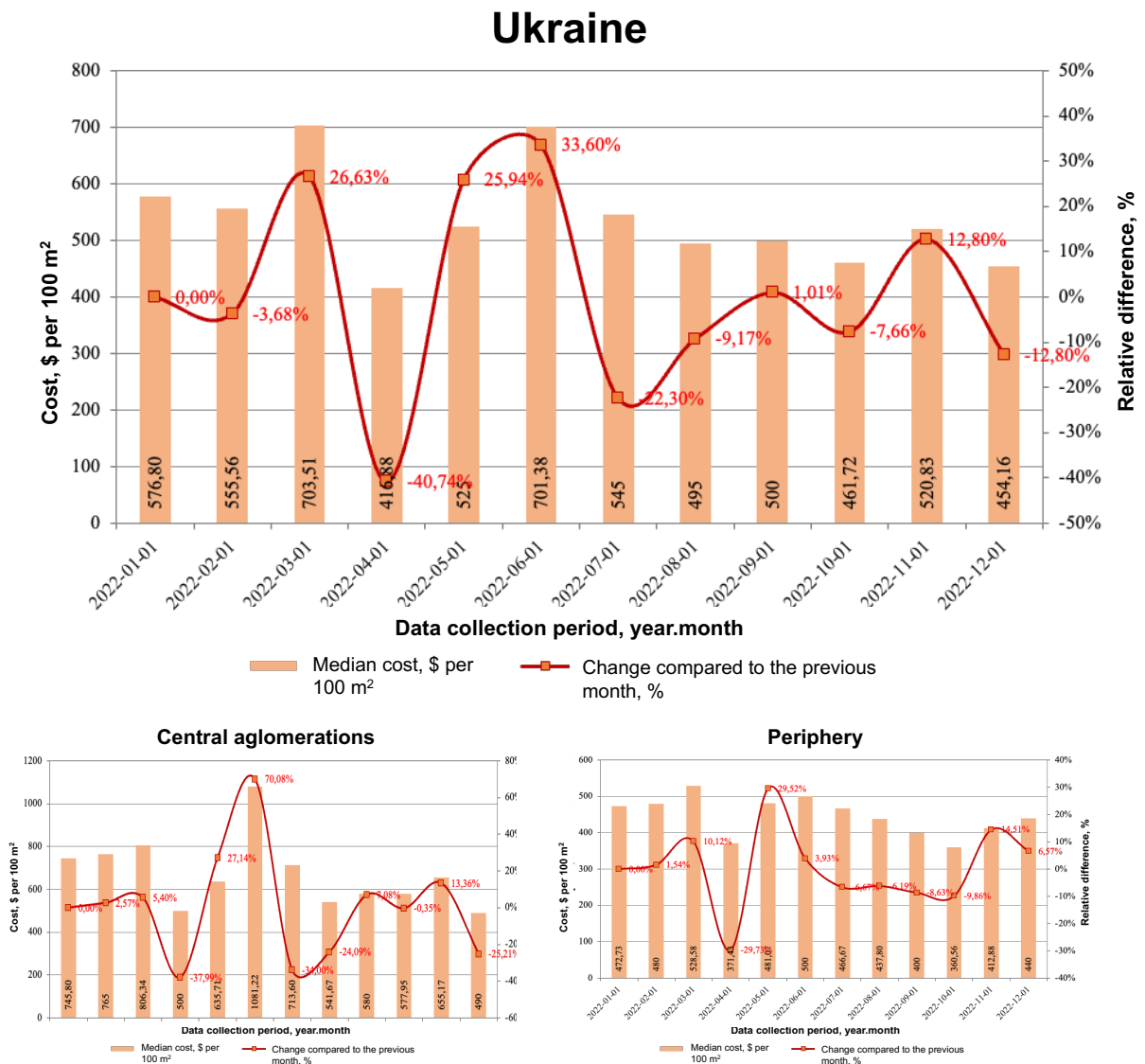


Fig. 2.11. Evolution of changes in the median value of the price per 100 m² of land holdings on the residential land market in Ukraine as of December 2022

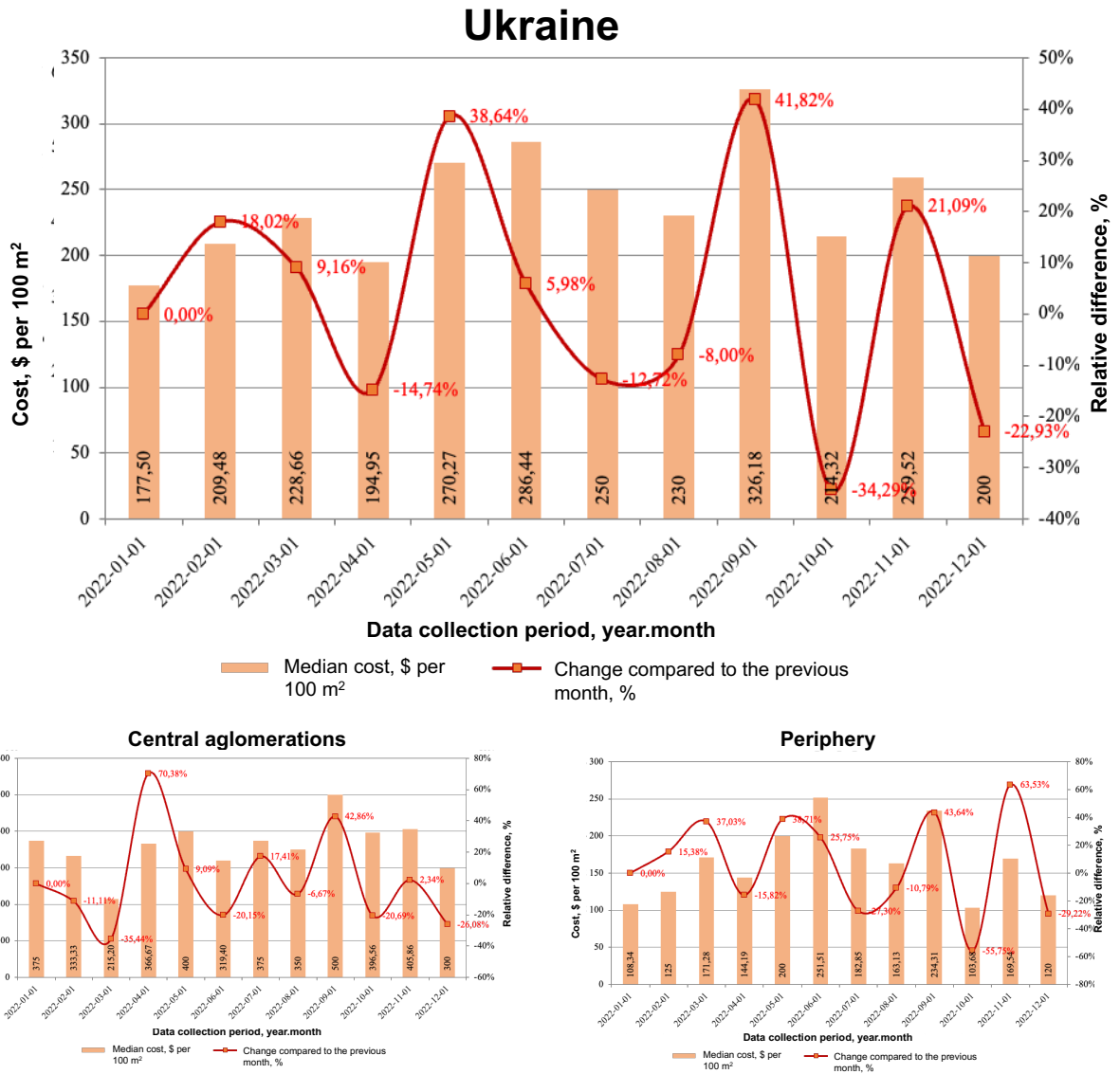
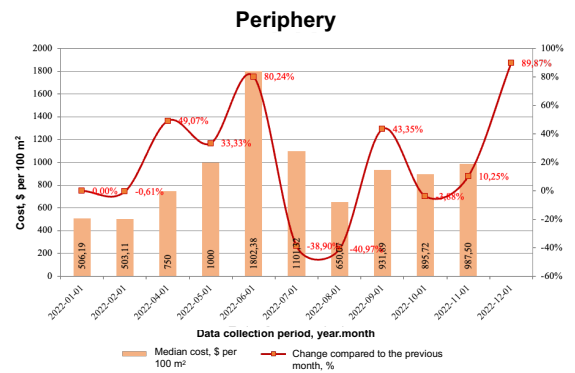
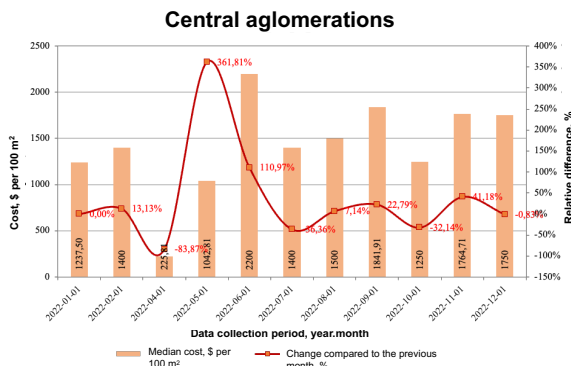
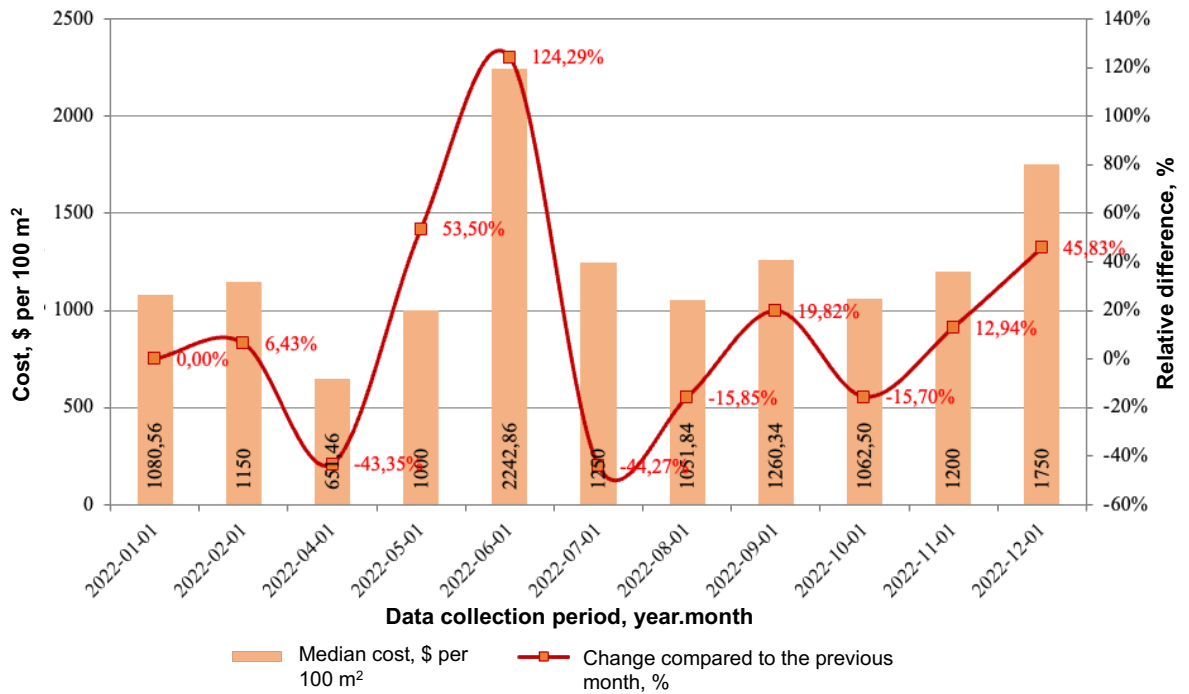


Fig. 2.12. Evolution of changes in the median value of the price per 100 m² of land holdings on the agricultural land market in Ukraine as of December 2022

Ukraine



Puc. 2.13. Evolution of changes in the median value of the price per 100 m² of land holdings on the industrial land market in Ukraine as of December 2022

The dynamics of changes in the value of different categories of land plots, taking into account not only the median values of the costs, but also their spread, is shown in Fig. 2.14-2.15.

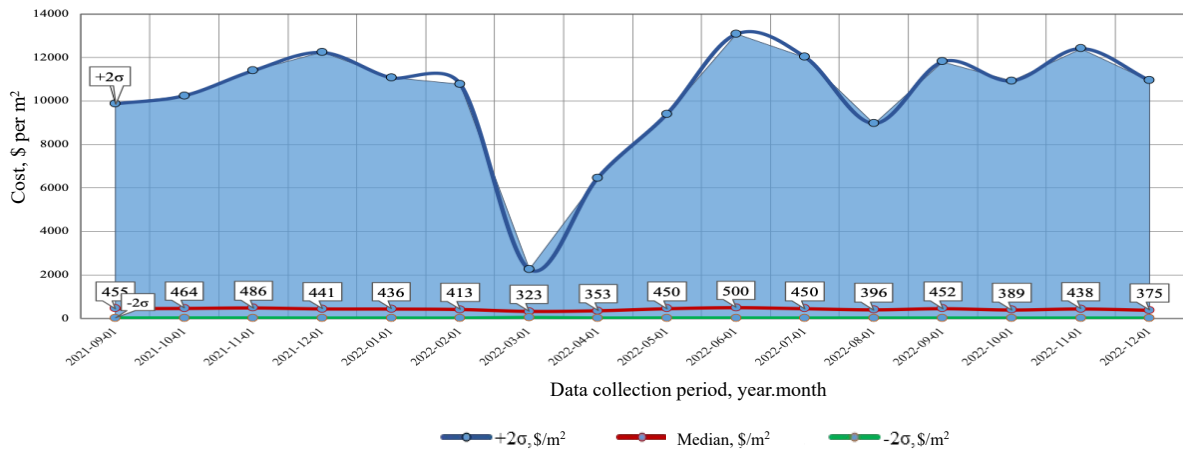
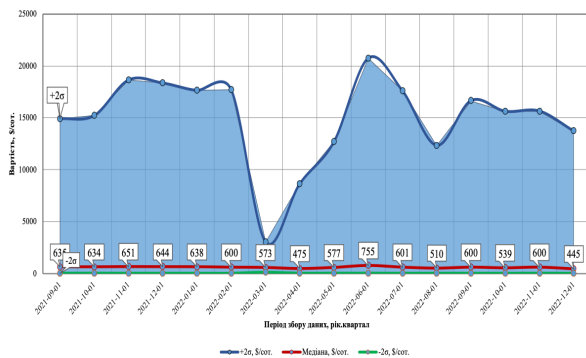
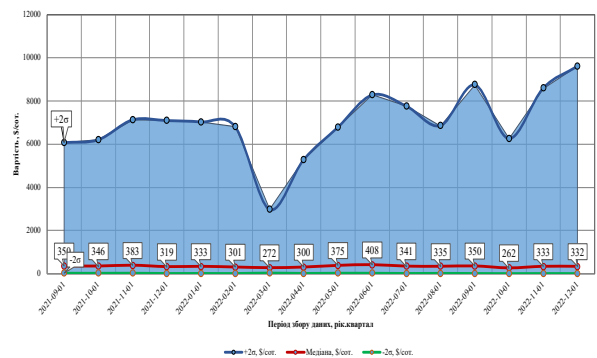


Fig. 2.14. Evolution of the median and marginal (95.46%) levels of the costs of 100 m2 of land plots in Ukraine as of December 2022 (Generalized sample)



Central agglomerations



Periphery

Fig. 2.15. Evolution of the median and marginal (95.46%) levels of the costs of 100 m2 of land plots in Ukraine as of December 2022

The information base of the land market allows for analysis of the impact on the value of important price-forming factors. To carry out a comprehensive analysis of the market of land plots in Ukraine, it is necessary to determine the median price per square meter depending on the type of soil, location, natural environment and method of use (Table 1.8 - 1.11).

Table 2.5. Parameters of the cost of 100 sq. m of land as of December 2022, depending on the location

Location	Average	Amount of offers	Coefficient of variation, %	Median (μ)	Lower confidence limit interval	Upper confidence limit interval
In the village	1121,84	973,00	0,97	550,85	46,21	6566,14
On the farm	1037,27	46,00	1,08	564,41	38,85	8198,71
Outside the settlement	1088,26	524,00	1,12	583,04	37,58	9046,61
In a dacha cooperative	1427,18	234,00	0,84	927,09	100,91	8515,91
In the garden society	2022,84	120,00	1,05	974,35	70,96	13378,89
In the settlement	2457,59	3465,00	1,01	1125,00	88,16	14355,24
In a cottage town	3522,65	986,00	0,98	1700,00	140,43	20580,38

Table 2.6. Parameters of the cost of 100 sq. m of land as of December 2022, depending on the soil

Soil	Average	Amount of offers	Coefficient of variation, %	Median (μ)	Lower confidence limit interval	Upper confidence limit interval
Black soil	1905,05	3666,00	1,07	900,00	63,28	12799,45
Argillaceous	2137,56	298,00	0,88	1200,00	119,85	12015,19
Sandy	2959,64	320,00	1,18	1375,00	80,53	23468,44
Stony	2233,40	42,00	1,11	1699,06	112,27	25703,60

Table 2.7. Parameters of the cost of 100 sq. m of land as of December 2022, depending on the natural environment

Natural environment	Average	Amount of offers	Coefficient of variation, %	Median (μ)	Lower confidence limit interval	Upper confidence limit interval
Forest	1146,97	19377,00	1,20	470,59	26,88	8239,11
The hills	1126,11	5093,00	1,24	470,59	25,29	8755,98
Reservoir	1220,75	2582,00	1,19	474,46	27,47	8196,02
River	1214,83	17226,00	1,20	498,66	28,23	8808,30
Lake	1298,58	13503,00	1,18	526,32	31,10	8908,22
Mountains	1172,70	3104,00	1,30	583,33	28,55	11916,82

Islands	2336,04	493,00	1,32	833,33	39,61	17534,02
Park	2415,73	4217,00	1,41	833,33	34,73	19994,36
Sea	2792,58	1634,00	1,40	1055,72	44,72	24921,12

3. INFORMATION AND ANALYTICAL UNIT OF THE HOUSEHOLD MARKET

As of the end of December 2022, the total information base of the home ownership market is more than 22,000 unique offers. Analyzing the volume of the market, which falls on different categories of rooms, you can see a high financial capacity, which is more than 5.4 billion dollars. USA (Fig. 3.1).

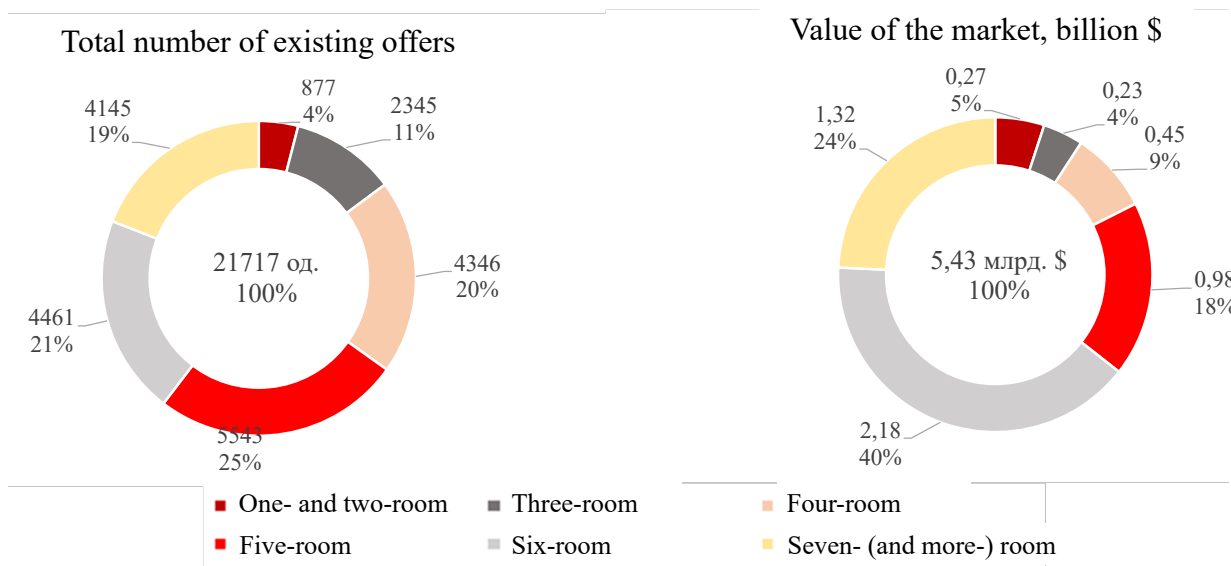


Fig. 3.1. Volume of the household market in Ukraine as of December 2022

The total number of existing offers for sale in the second half of 2022 amounted to 21717 home ownerships (Fig. 3.1). The largest share of offers for sale falls on five- and six-room houses, which for them is 25% and 21% of the total number of apartments offered for sale, respectively. For four- and seven-room offers, this share is also significant, reaching 20% and 19%, respectively. Thus, 15% of the total number of offers remains for 1-, 2-, and 3-room houses.

In monetary terms, the value of the household market in Ukraine as of December amounted to more than 5 billion dollars. USA (Fig. 3.1). The largest share in it falls again on six- and seven-room offers - 40% and 24%, respectively, while five-room - 18%. The share of 4-room apartments in monetary terms is already 9%, 1-, 2-, and 3-room apartments, respectively, 9%.

The indicators of the market volume in Ukraine for the period 2021-2022 in dynamics allow us to analyze how certain factors influenced market activity (Fig. 3.2, 3.3). Since the beginning of 2022, there has been a decline, which is associated with political and economic instability in the country. We see that April 2022 has become the most critical, both in terms of quantitative and cost results. It is obvious that the reason was the beginning of a full-

scale war, which shook the market. Currently, relative stabilization is observed, although the indicators are still far from the pre-war level.

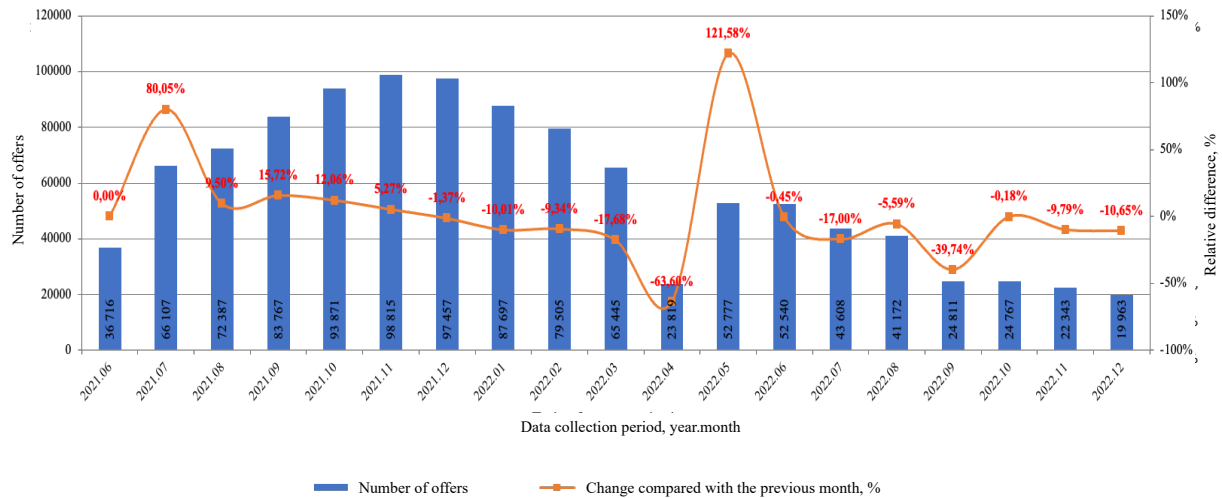


Fig. 3.3. Evolution of the number of offers on the secondary household market in Ukraine, 2021-2022

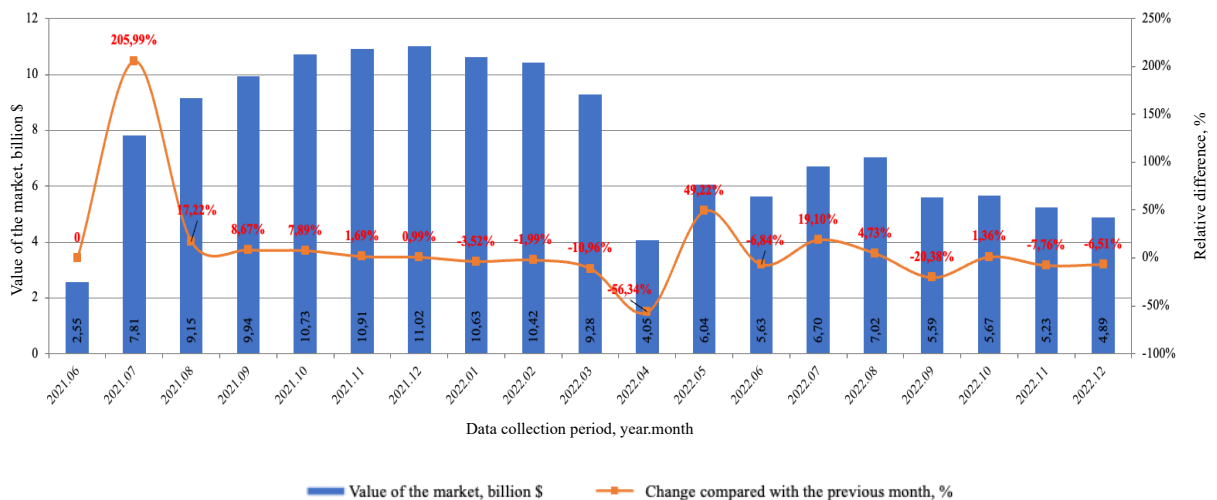


Fig. 3.4. Evolution of the value of the secondary household market in Ukraine, 2021-2022

The conducted statistical analysis, performed using the most powerful significance criteria, demonstrated that the distribution of prices on the housing market is also subject to the log-normal distribution law (Fig. 3.4, 3.5). Checking the validity of this significant conclusion for individual regions and time intervals confirmed its robustness (Fig. 3.6).

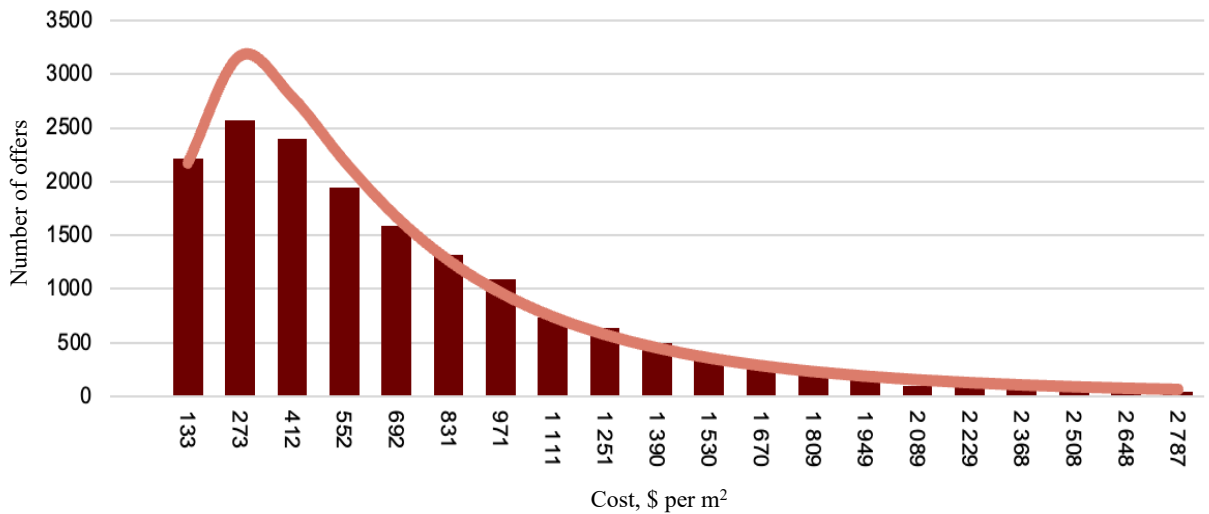


Fig. 3.4. Density distribution cost of 1 m² on the secondary household market of Ukraine as of December 2022

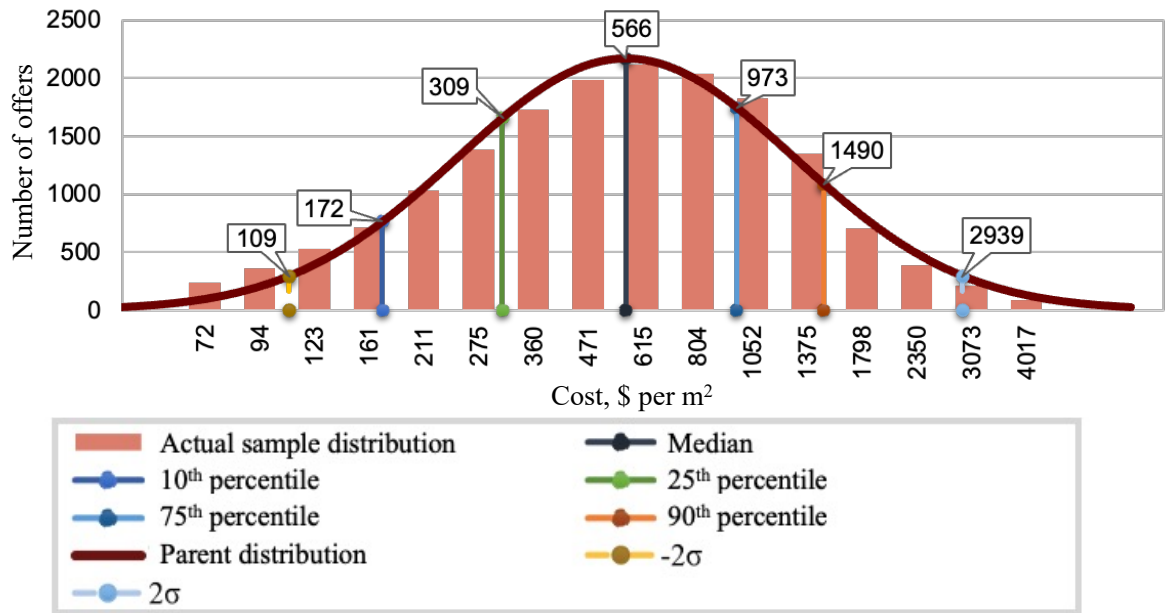
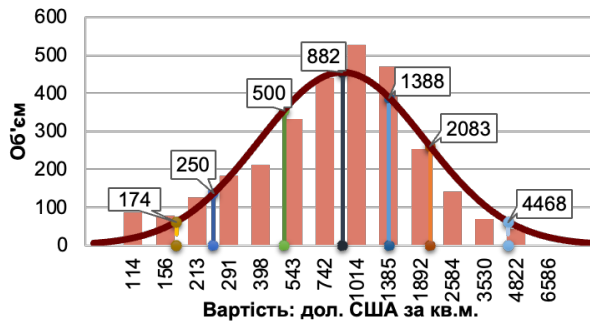
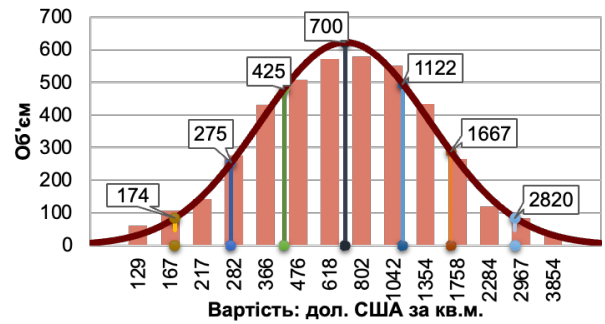


Fig. 3.5. Description of the density distribution of the cost of 1 m² on the secondary household market of Ukraine as of December 2022 according to the log-normal distribution law

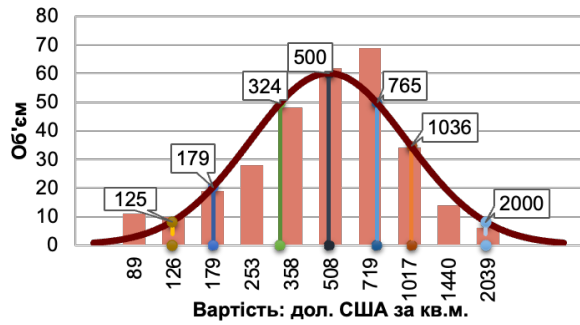
Thus, compliance with the log-normal distribution law is confirmed for all considered categories of real estate, including apartments, land plots of any purpose, and home ownership. This opens up the possibility of applying a single methodology for processing the primary information database for these real estate groups.



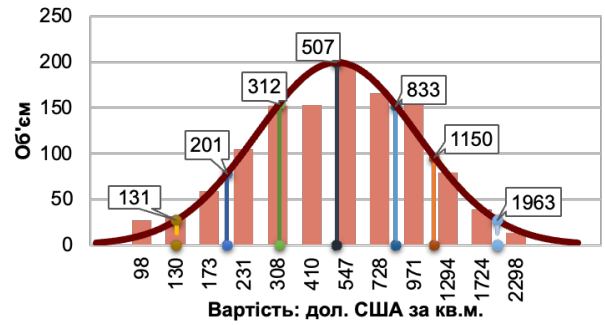
Kyiv region. Cost: $\$/m^2$



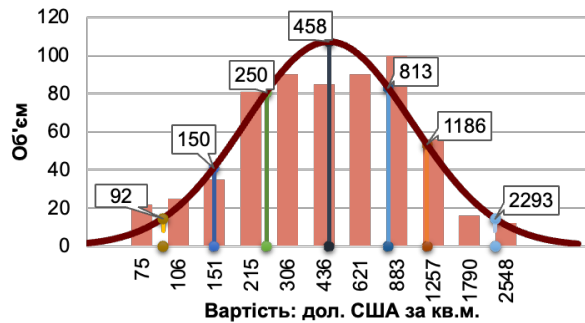
Odesa region. Cost: $\$/m^2$



Kharkiv region. Cost: $\$/m^2$



Dnipropetrovsk region. Cost: $\$/m^2$



Lviv region. Cost: $\$/m^2$

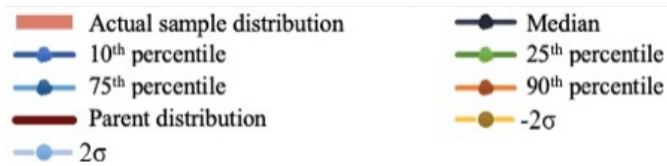


Fig. 3.6. Description of the density of the distribution of the cost of 1 m² of households on the secondary market of the largest cities of Ukraine as of December 2022 by the log-normal distribution law

Below are summarized data on the cost distribution parameters of 1 square meter. of households for all regions without exception, which includes not only the average and median values, but also the level of their dispersion and variation, which fully describes the probabilistic and statistical parameters of these distributions (Table 3.1).

Table 3.1. Parameters of cost distribution 1 m² of secondary household market in regional centers of Ukraine as of December 2022

Region	Amount of offers	Median (μ)	Average	S _{lg} (σ)	Coefficient of variations	Lower confidence limit interval	Upper confidence limit interval
Vinnytsia region	1361	647	708	0,288	45,94%	171	2441
	372	239	308	0,277	44,02%	67	859
Volyn region	60	540	599	0,299	47,73%	137	2136
	10	176	288	0,356	58,27%	34	908
Dnipropetrovsk region	1079	593	684	0,274	43,47%	168	2095
	254	653	740	0,321	51,78%	149	2867
Donetsk region	7	300	381	0,291	46,38%	79	1145
	2	411	411	0,010	1,51%	393	431
Zhytomyr region	243	429	495	0,319	51,46%	98	1866
	84	234	283	0,296	47,22%	60	912
Transcarpathian region	531	648	718	0,2496	39,27%	205	2046
	91	382	438	0,246	38,61%	123	1183
Zaporizhzhia region	175	592	668	0,261	41,24%	178	1971
	28	373	536	0,357	58,33%	72	1929
Ivano-Frankivsk region	361	539	584	0,263	41,61%	160	1813
	65	346	441	0,288	45,88%	92	1302
Kyiv region	2402	1054	1261	0,286	45,60%	282	3943
	2474	1133	1400	0,302	48,31%	282	4550
Kirovohrad region	499	425	499	0,278	44,14%	118	1529
	22	194	309	0,312	50,04%	46	815
Luhansk region	2	176	178	0,086	13,17%	118	262
	2	127	150	0,366	60,17%	24	687
Lviv region	471	640	751	0,333	53,84%	138	2959
	139	320	489	0,348	56,79%	64	1595
Mykolaiv region	73	337	505	0,339	55,02%	71	1607
	29	219	319	0,343	55,71%	45	1060
Odesa region	6383	833	973	0,275	43,64%	235	2959
	1982	497	619	0,277	43,99%	139	1780
Poltava	814	550	628	0,272	43,11%	157	1925
	120	283	368	0,312	50,09%	67	1190
Rivne region	291	500	615	0,287	45,70%	133	1875
	86	257	309	0,286	45,54%	69	960
Sumy region	44	397	411	0,365	59,99%	74	2135
	13	101	174	0,399	66,53%	16	634
Ternopil region	423	390	477	0,308	49,39%	94	1610
	121	220	270	0,261	41,17%	66	731
Kharkiv region	339	636	680	0,255	40,10%	197	2055
	48	405	528	0,277	43,90%	113	1447
Kherson region	517	609	675	0,213	33,15%	228	1622
	15	457	566	0,232	36,32%	157	1330

Khmelnyskyi region	412	450	529	0,295	47,04%	116	1748
	100	202	285	0,325	52,51%	45	904
Cherkasy region	192	356	458	0,400	66,79%	56	2249
	89	189	331	0,384	63,57%	32	1106
Chernivtsi region	136	530	602	0,309	49,62%	128	2200
	34	290	377	0,302	48,27%	72	1163
Chernihiv region	64	266	311	0,312	50,16%	63	1119
	79	181	223	0,351	57,19%	36	907



In addition to this general picture, the information base of the land market allows for the analysis of the impact on the value of the most important price-forming factors. To carry out a comprehensive analysis of the home ownership market in Ukraine, it is necessary to determine the median price per square meter depending on the type of home ownership and location (Table 3.2).

Table 3.2. Dependence of the median cost on the category of home ownership

Sample	Type of home ownership	Distance to the nearest city	Median cost, \$/m ²	Absolute difference from the baseline, \$/m ²	Relative difference from baseline, %
Whole Ukraine	House	All	310,08	-	-
		From 10 to 50 km	158,88	-151,21	-48,76%
		Up to 10 km	750,00	439,92	141,87%
	Cottage	All	382,35	-	-
		From 10 to 50 km	498,39	116,04	30,35%
		Up to 10 km	382,35	0,00	0,00%
Central agglomerations	House	All	477,27	-	-
		From 10 to 50 km	324,84	-152,43	-31,94%

		Up to 10 km	582,05	104,78	21,95%
	Cottage	All	225,00	-	-
		From 10 to 50 km	206,67	-18,33	-8,15%
		Up to 10 km	250,00	25,00	11,11%
Periphery	House	All	210,53	-	-
		From 10 to 50 km	130,43	-80,10	-38,05%
		Up to 10 km	280,00	69,47	33,00%
	Cottage	All	142,83	-	-
		From 10 to 50 km	120,00	-22,83	-15,98%
		Up to 10 km	166,67	23,84	16,69%

The dependence of the cost of 1 square meter of home ownership on the total area and agricultural plots is shown in fig. 3.7 - 3.8.

The resulting quantitative equations, which provide an approximation of these empirical dependencies, make it possible to use them to make a direct adjustment when comparing the value of analogues and evaluation objects existing on the market.

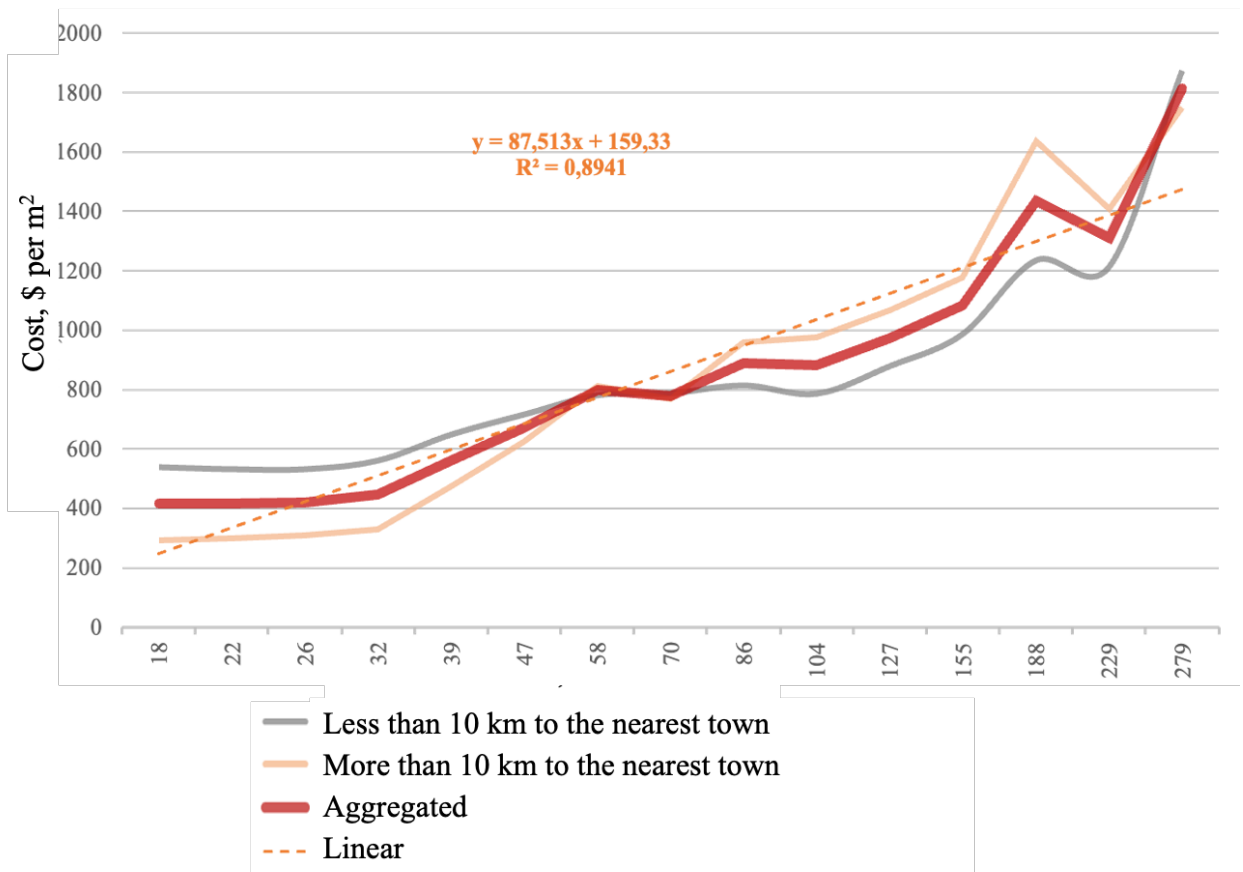
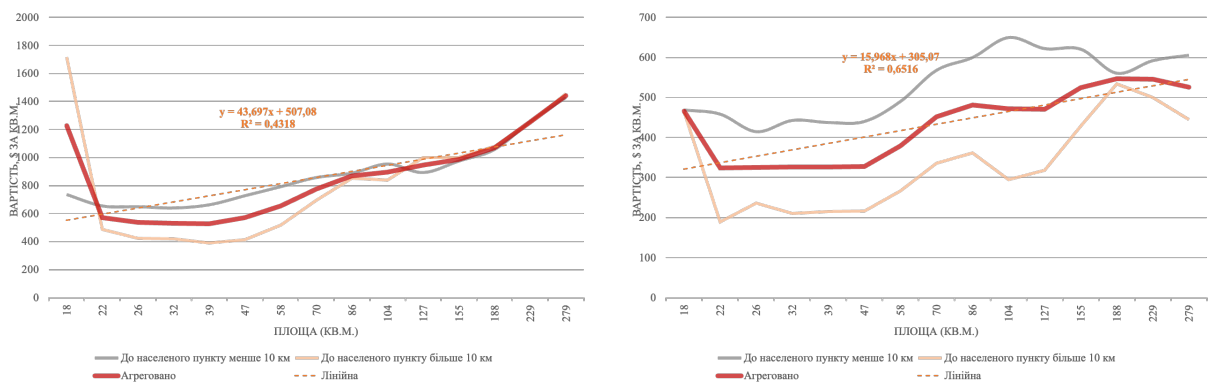


Fig. 3.7. Dependence of the cost of 1 sq. m of households from their total area (all of Ukraine)



Central agglomerations

Peryphery

Fig. 3.8. Dependence of the cost of 1 sq. m of households from their total area (depending on the location)