



**INFORMATION BASE AND ANALYTICS OF
THE REAL ESTATE MARKET OF UKRAINE.
CALCULATION MODULE "SMART-ASSESSMENT"**



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 September 2022, the database in the context of the secondary apartment market includes about 1 million 200 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.

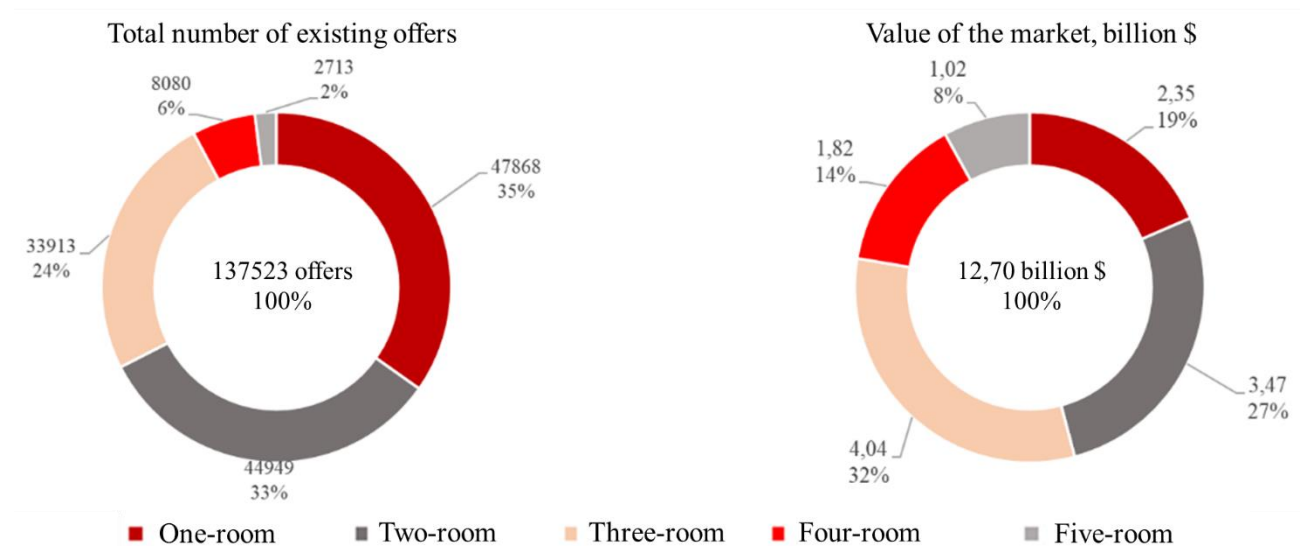


Fig. 1. 1. Volume of the secondary apartment market in Ukraine as of September 2022

The total number of existing offers for sale in the first half of 2022 amounted to more than 135,000 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 33% of the total number of apartments offered for sale. For three-room apartments, this share is also significant, reaching 24%. 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 September amounted to more than 12.70 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 19 per cent. The share of 4-room apartments is already 14%, 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

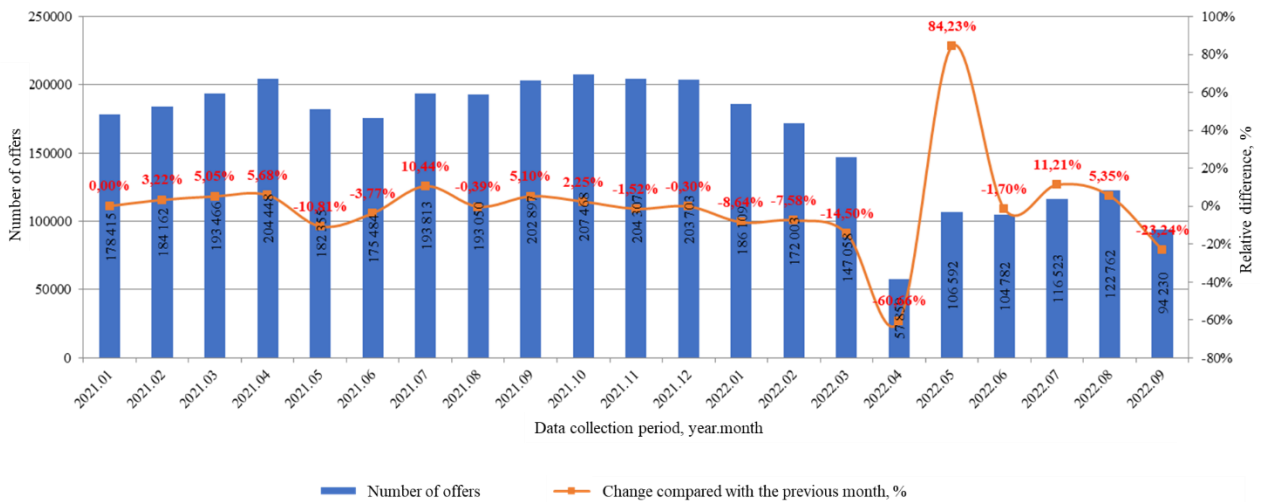


Fig. 1.2. Dynamics of the number of offers on the secondary market of apartments in Ukraine, 2021-2022

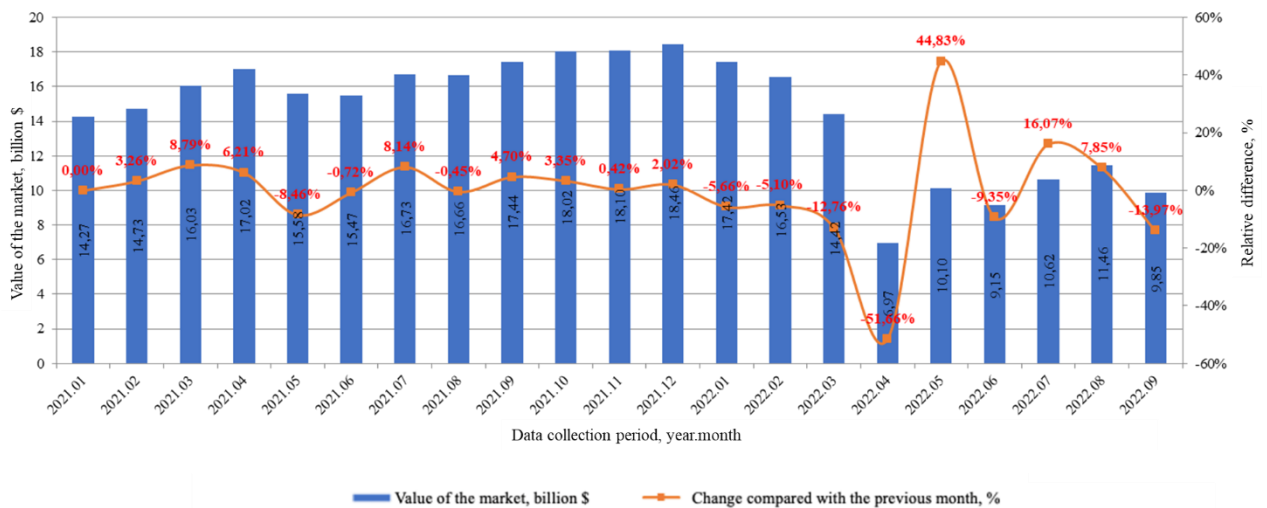


Fig. 1.3. Dynamics of the value of the secondary market of apartments in Ukraine, 2021-2022, billion \$

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).

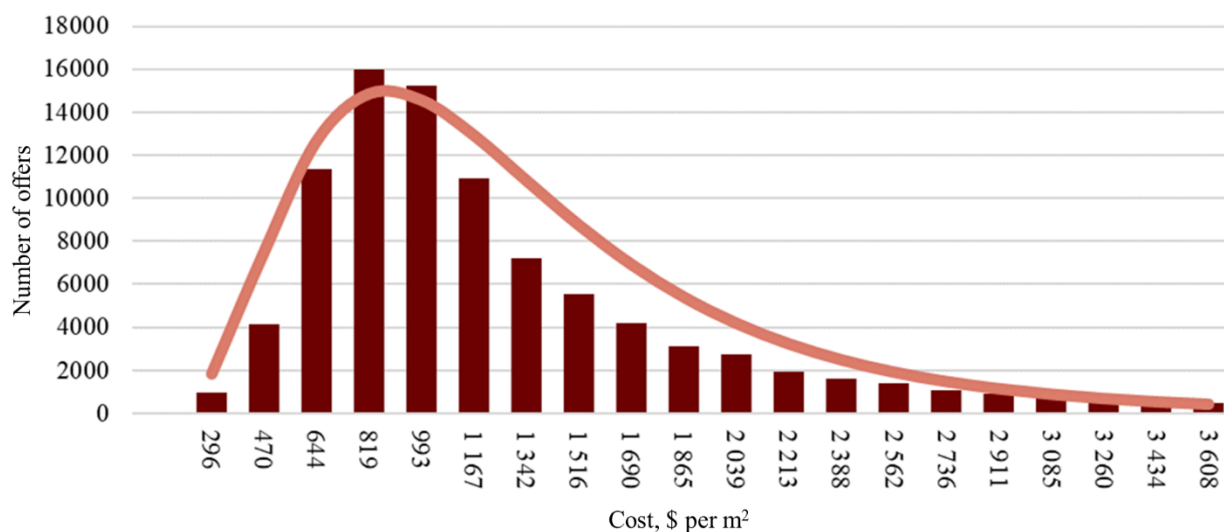


Fig. 1.4. Density distribution cost of 1 m² on the secondary apartment market of Ukraine as of September 2022

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: Lviv) as of September 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.

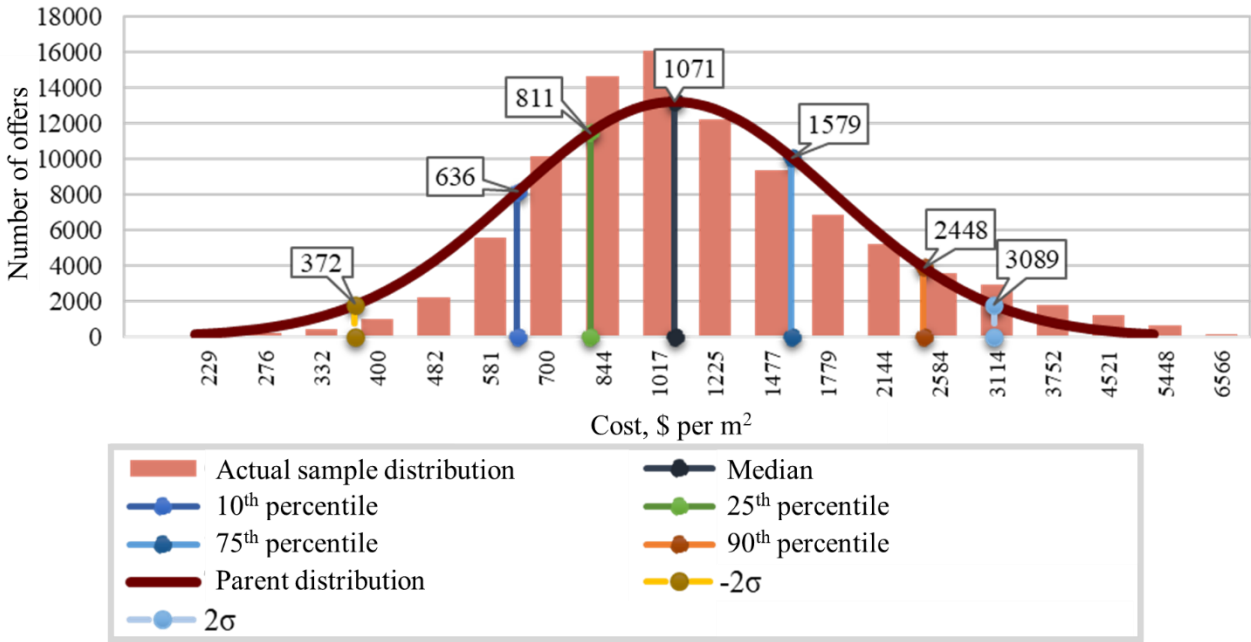


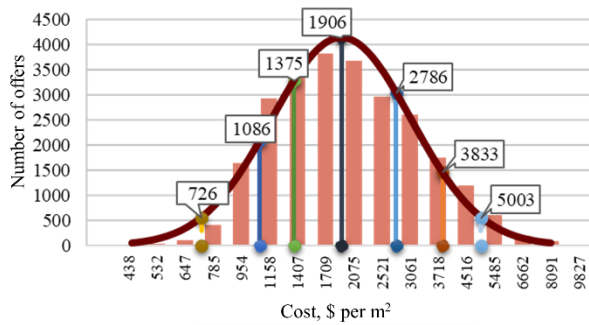
Fig. 1.5. Description of the density distribution of the cost of 1 m² on the secondary apartment market of Ukraine as of September 2022 according to the log -normal distribution law

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.

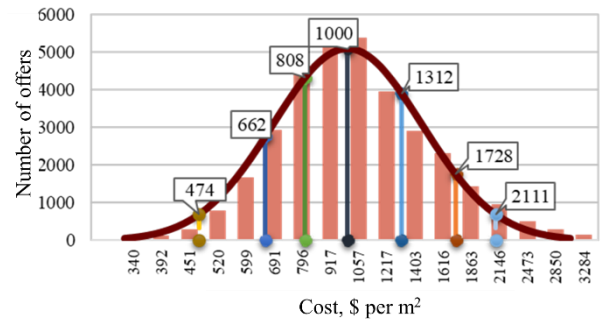
The median prices of apartments in Kyiv, Odesa: Kharkiv and Lviv on the secondary market in September 2022 were \$1,906 per m², \$1,000 per m², \$1,227 per m² and \$909 per m², respectively. In general, this indicator for the country is \$1,071 per m², thus, we can observe significant differences in 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.

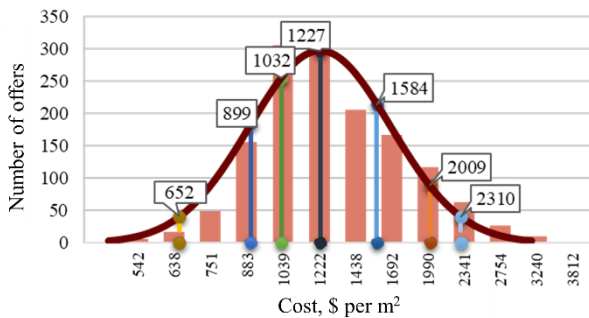
The summary table of the parameters of the distribution of this indicator for all without the exception of regional centers includes not only the average and median values, but also the level of their dispersion and variation, which fully describes the probabilistic -statistical parameters of these distributions (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.



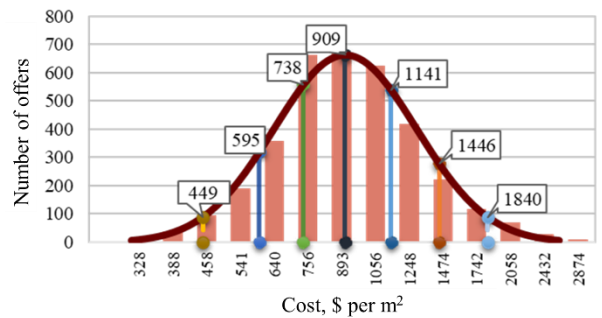
Kyiv. Cost: \$ per m²



Odesa. Cost: \$ per m²



Lviv. Cost: \$ per m²



Kharkiv. 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 September 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 September 2022

Region	Amount of offers	Median (μ)	Average	$S_{lg}(\sigma)$	Coefficient of variations	Lower confidence limit interval	Upper confidence limit interval
Vinnytsia	2392	947	966	0.1013	15.46%	422	2069
Dnipro	5692	943	1034	0.1568	24.13%	294	3095
Zhytomyr	393	782	804	0.1126	17.22%	338	1625
Zaporizhzhia	993	647	685	0.1353	20.74%	220	1704
Ivano-Frankivsk	869	757	773	0.1220	18.67%	296	1738
Kyiv	25754	1906	2231	0.2095	32.62%	398	9709
Kropyvnytskyi	409	677	704	0.1180	18.05%	311	1500
Lutsk	86	764	808	0.0995	15.18%	463	1271
Lviv	1446	1227	1356	0.1369	20.99%	500	3485
Mykolayiv	199	704	727	0.1264	19.35%	328	1389
Odesa	33657	1000	1120	0.1623	25.00%	317	3448
Poltava	1177	841	882	0.1222	18.71%	321	2323
Rivne	665	818	844	0.1149	17.56%	342	1722
Sumy	189	602	625	0.1036	15.82%	326	1143
Ternopil	1156	824	836	0.1043	15.93%	368	1825
Uzhhorod	351	933	999	0.1364	20.92%	396	2643
Kharkiv	3518	909	979	0.1531	23.55%	302	2832
Kherson	1218	700	741	0.1215	18.59%	281	1600
Khmelnyskyi	1975	746	773	0.1075	16.43%	356	1644
Cherkasy	339	831	858	0.1239	18.97%	300	2143
Chernivtsi	277	843	866	0.1021	15.59%	414	1563
Chernihiv	97	658	701	0.1216	18.62%	309	1915

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 70-75 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).

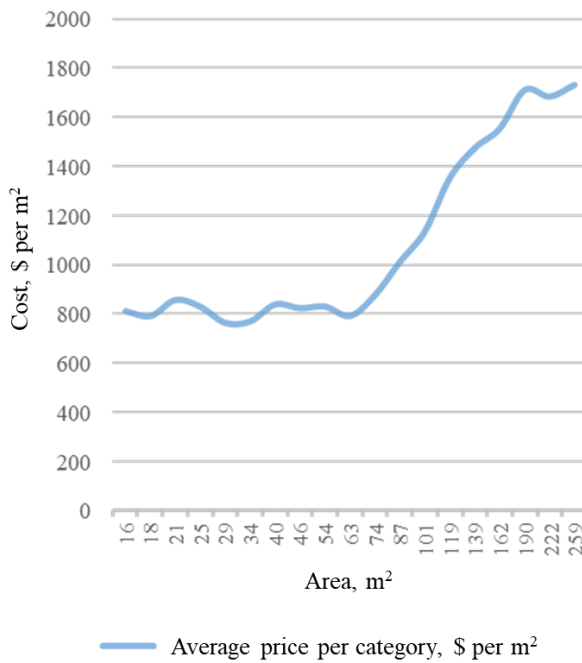


Fig. 1.7. The dependence of the average price on the area of apartments in Ukraine in September 2022

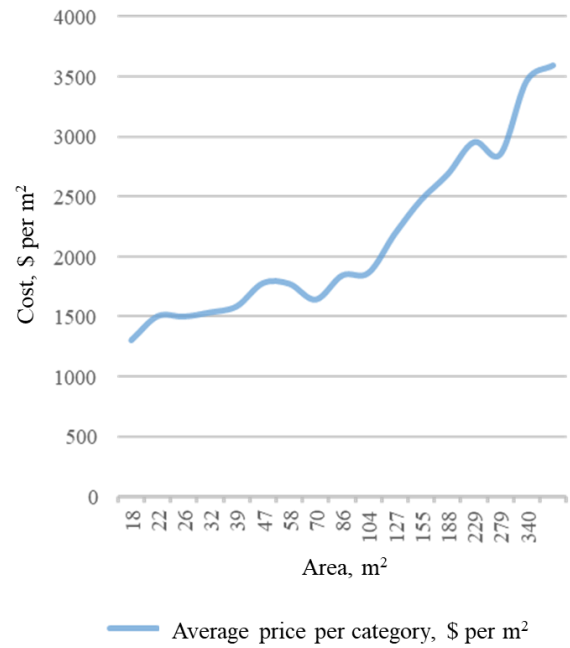


Fig. 1.8. The dependence of the average price on the area of apartments in Kyiv in September 2022

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	949	-312	-24.77%
		Average	1261	0	0.00%
		Last	1083	-178	-14.12%
	The biggest cities *	First	980	-374	-27.64%
		Average	1354	0	0.00%
		Last	1203	-151	-11.16%
	Other cities	First	875	-125	-12.50%
		Average	1000	0	0.00%
		Last	900	-100	-10.00%
Less or exactly 9 floors	Ukraine as a whole	First	836	-94	-10.15%
		Average	930	0	0.00%
		Last	818	-112	-12.05%
	The biggest cities *	First	945	-193	-16.97%
		Average	1139	0	0.00%
		Last	978	-160	-14.09%
	Other cities	First	734	-66	-8.22%
		Average	800	0	0.00%
		Last	691	-109	-13.67%

* Kyiv, Lviv, Odessa, Kharkiv

Table 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	886	71	8.75%
		Cosmetic repair	892	78	9.52%
		Eurorenovation	1186	371	45.52%
		Author's project	1733	918	112.69%
	The biggest cities *	Housing condition	994	0	0.00%
		Just built	975	-19	-1.89%
		Cosmetic repair	1000	6	0.59%

		Eurorenovation	1344	350	35.20%	
		Author's project	2102	1107	111.39%	
	Other cities	Housing condition	631	0	0.00%	
		Just built	718	87	13.85%	
		Cosmetic repair	722	92	14.53%	
		Eurorenovation	1000	369	58.58%	
		Author's project	1128	498	78.91%	
	Less or exactly 9 floors	Ukraine as a whole	Housing condition	455	0	0.00%
			Just built	744	289	63.61%
			Cosmetic repair	584	129	28.41%
			Eurorenovation	850	395	87.00%
			Author's project	1048	594	130.64%
The biggest cities *		Housing condition	902	0	0.00%	
		Just built	893	-10	-1.05%	
		Cosmetic repair	1000	98	10.82%	
		Eurorenovation	1207	305	33.75%	
		Author's project	1895	993	110.02%	
Other cities		Housing condition	386	0	0.00%	
		Just built	658	272	70.54%	
	Cosmetic repair	506	120	31.10%		
	Eurorenovation	729	343	88.92%		
	Author's project	842	456	118.24%		

* Kyiv, Lviv, Odessa, Kharkiv

Table 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 m2	Absolute difference with the baseline, \$ per m2	Relative difference from baseline, %
More than 9 floors	Ukraine as a whole	1	1093	0	0.00%
		2	1085	-9	-0.78%
		3	1134	41	3.77%
		4	1429	336	30.70%
		5	1634	541	49.49%
	The biggest cities *	1	1182	0	0.00%
		2	1212	30	2.51%
		3	1298	116	9.82%
		4	1728	546	46.19%
		5	1982	800	67.71%
	Other cities	1	918	0	0.00%

		2	871	-47	-5.14%
		3	854	-64	-6.99%
		4	780	-138	-15.07%
		5	801	-117	-12.79%
Less or exactly 9 floors	Ukraine as a whole	1	842	0	0.00%
		2	738	-104	-12.35%
		3	693	-149	-17.68%
		4	714	-128	-15.18%
		5	896	53	6.34%
	The biggest cities *	1	1091	0	0.00%
		2	1054	-37	-3.40%
		3	1000	-91	-8.33%
		4	1031	-60	-5.50%
		5	1099	8	0.70%
	Other cities	1	718	0	0.00%
		2	623	-95	-13.24%
		3	579	-139	-19.36%
		4	563	-155	-21.65%
		5	611	-107	-14.88%

* Kyiv, 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. For the rest of the cities, the lower limit of the cost difference between these two states is 14%. 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.

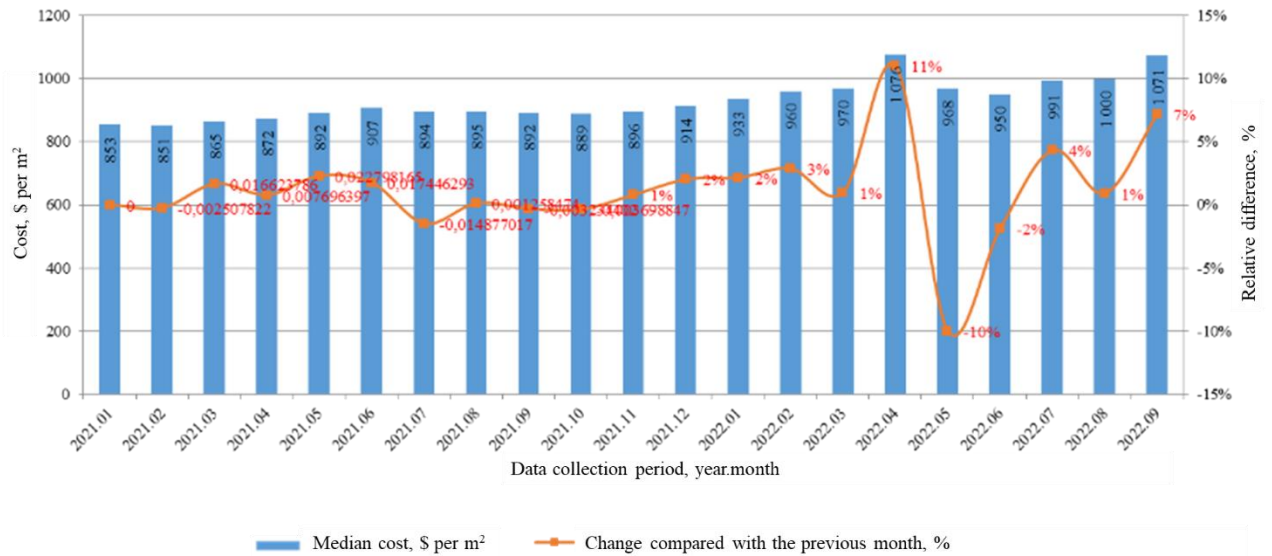


Fig. 1.9. Dynamics of the median cost per m² on the secondary apartment market in Ukraine, 2021-2022

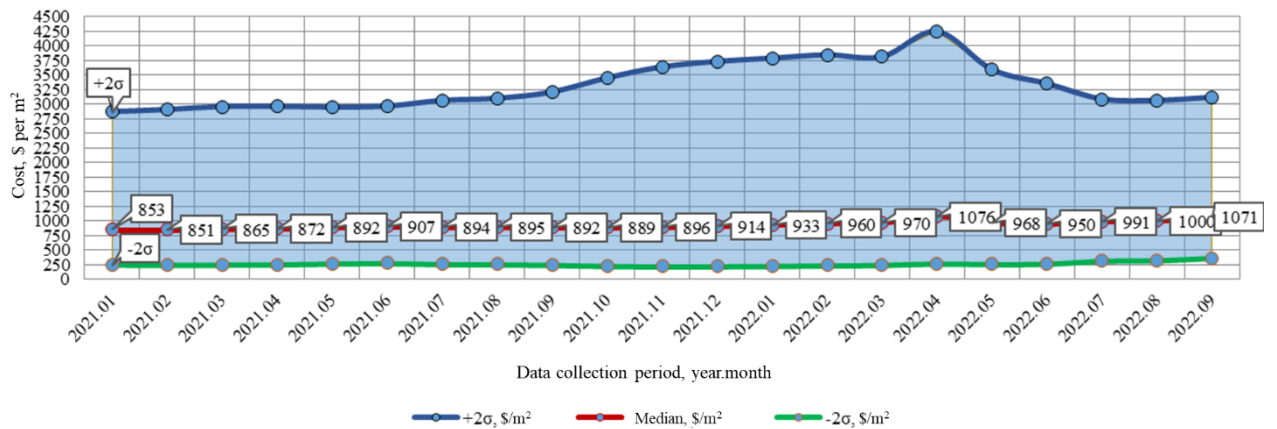
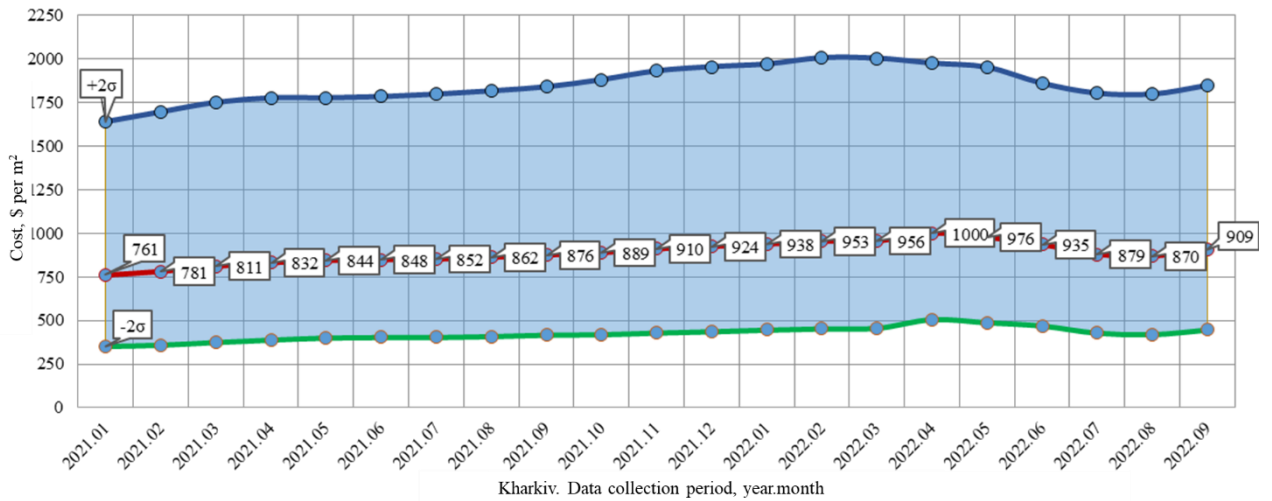
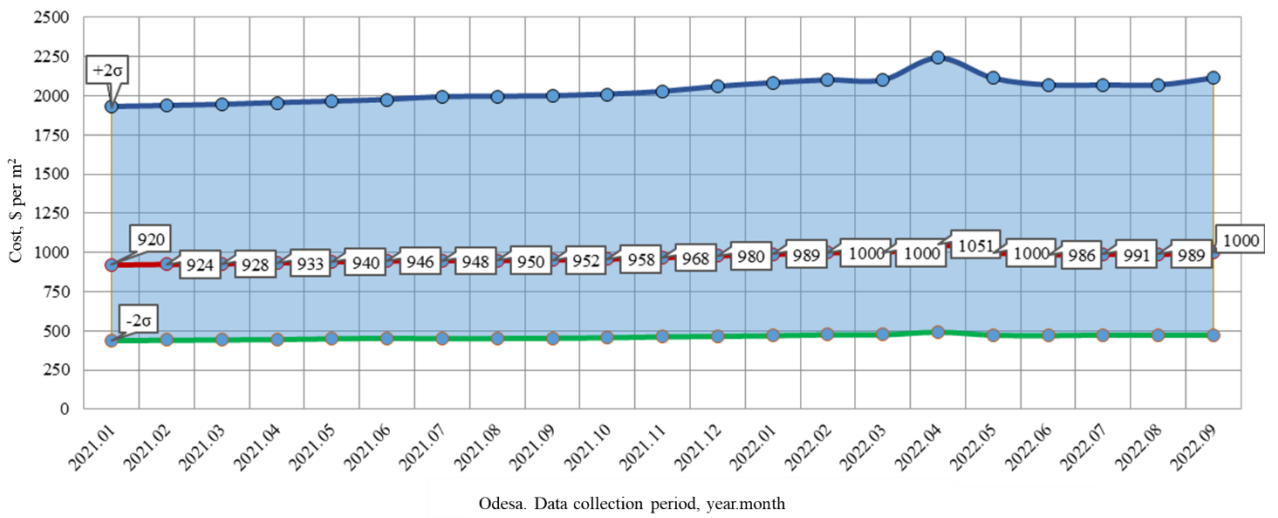
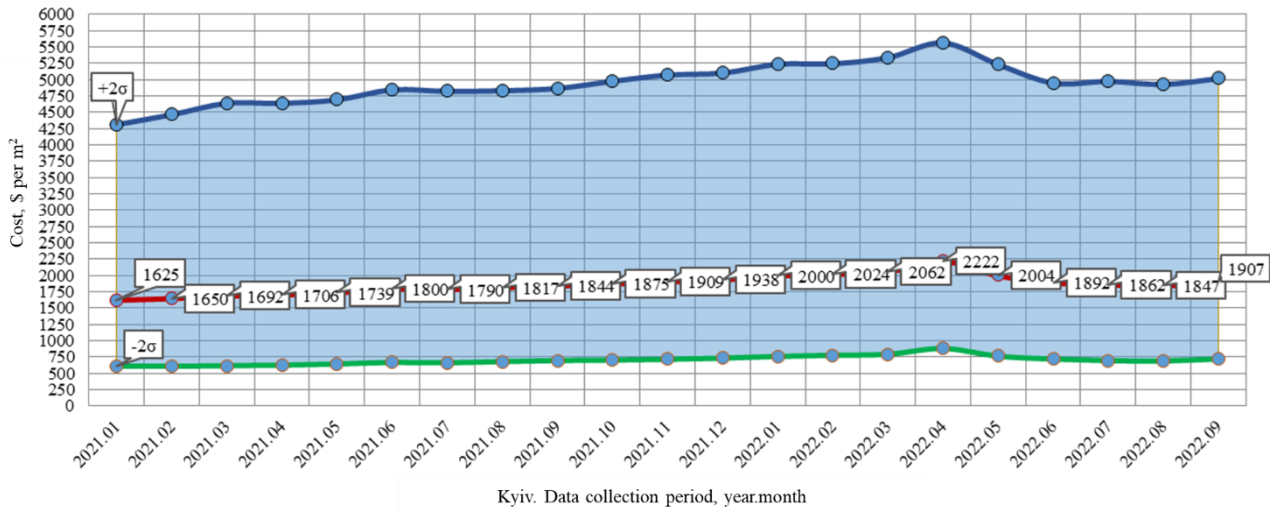


Fig. 1.10. Dynamics of the median and marginal cost per m² on the secondary apartment market in Ukraine, 2021-2022



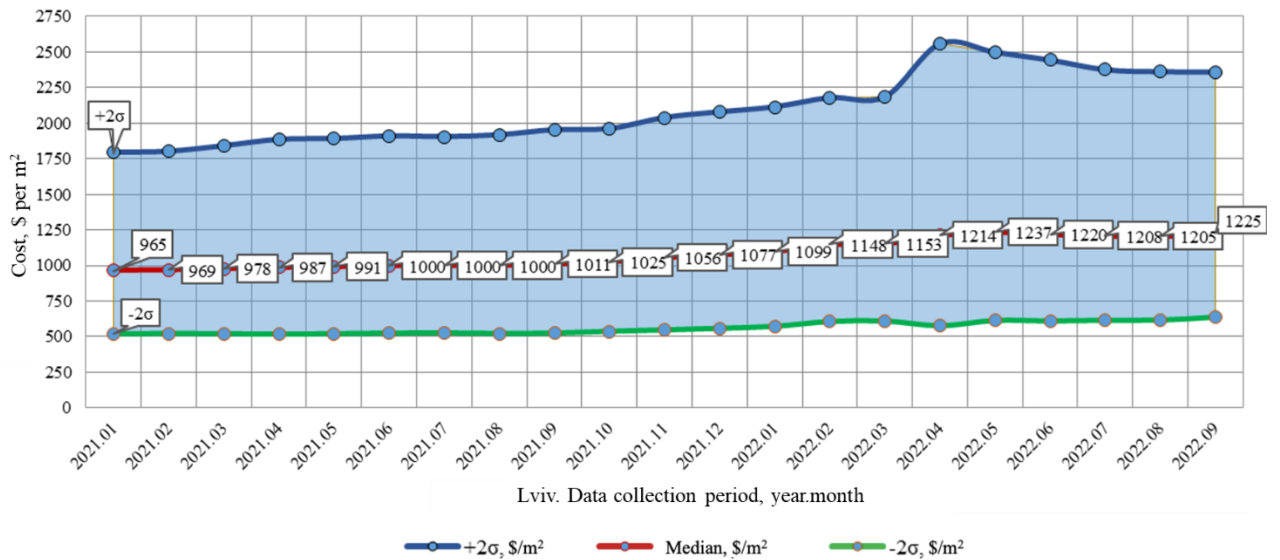


Fig. 1.11. Dynamics of the median cost per m² on the secondary apartment market in the largest cities, 2021-2022

In contrast to the situation in 2020-2021, when during the pandemic the coefficient of variation of the cost of 1 m² 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.

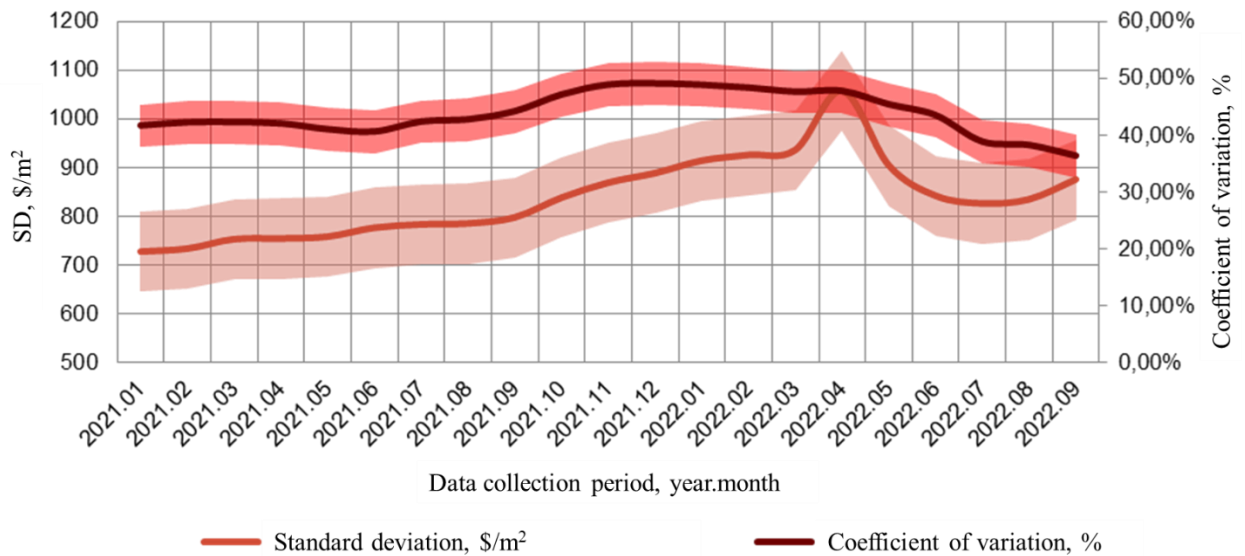
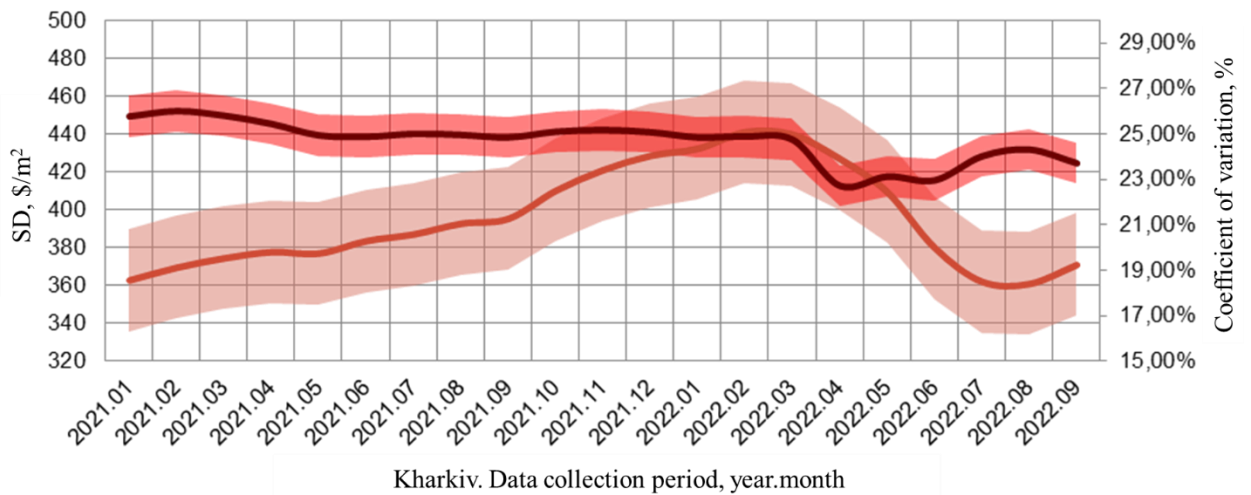
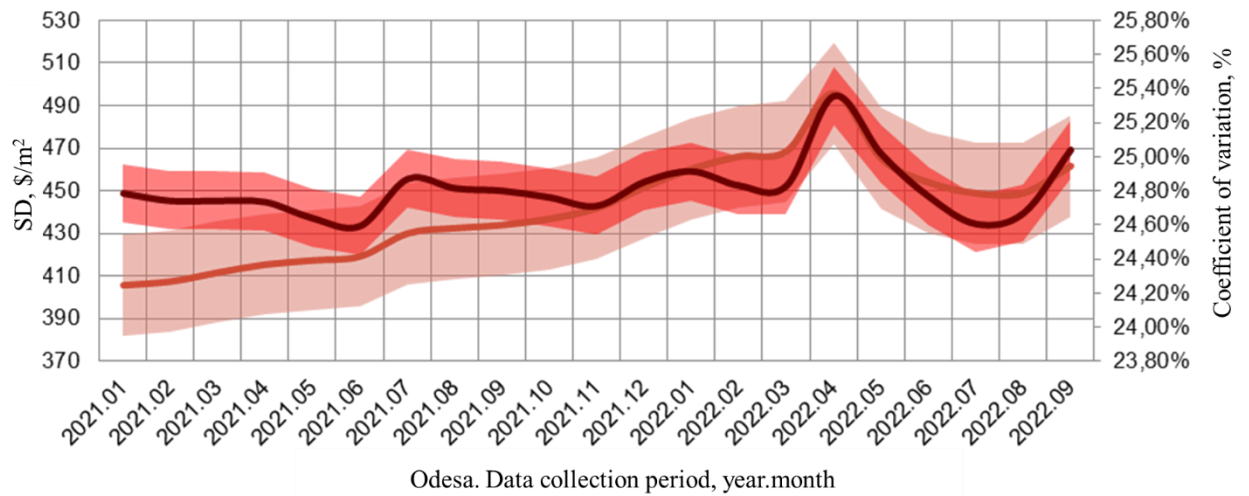
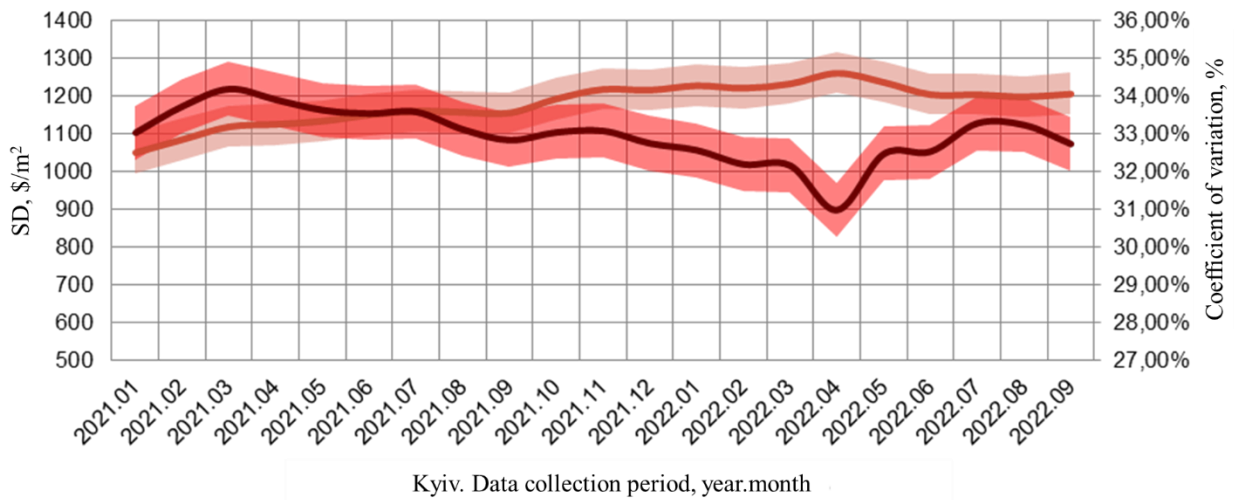


Fig. 1.12. Dynamics of dispersion and coefficient of variation of the cost of 1 m² on the secondary housing market in Ukraine, 2021-2022



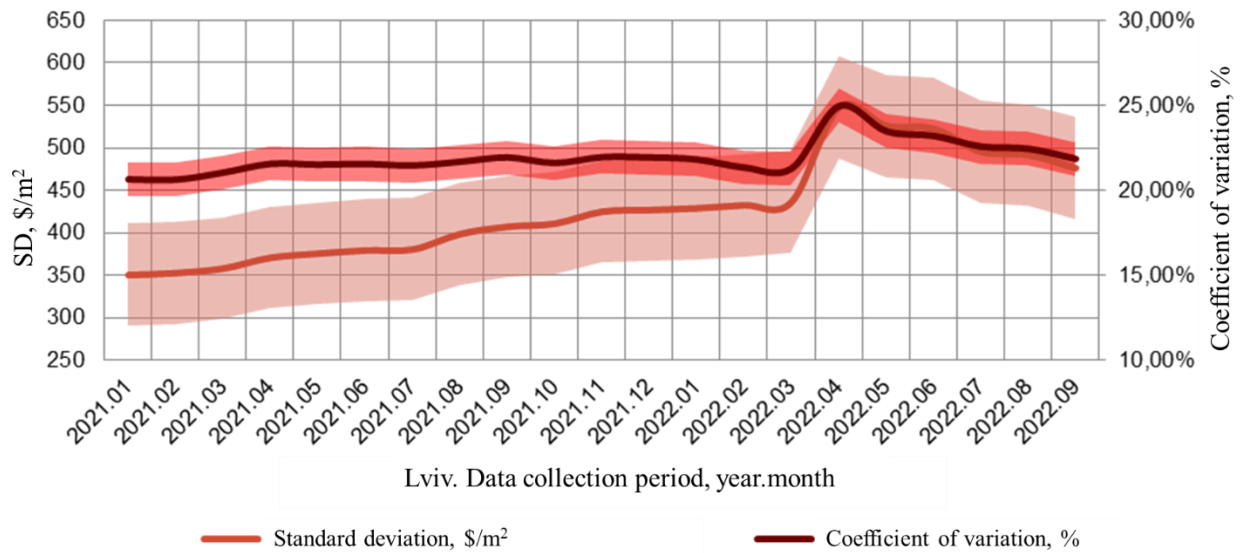


Fig. 1.13. Dynamics of dispersion and coefficient of variation of the cost of 1 m² on the secondary housing market in the largest cities, 2021-2022

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.

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 the III quarter of 2022, the information base of the land market covers about 30,500 unique offers, where 71% are residential plots, 26% - agricultural plots, and 3% - industrial plots. The total value of the land market currently is 2.59 billion dollars. USA. (Fig. 2.1).

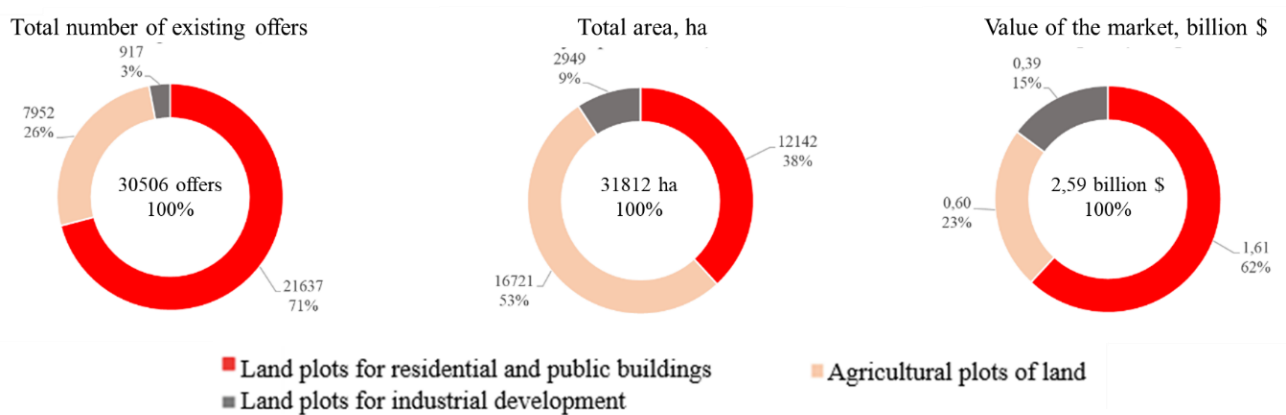


Fig. 2.1. Volume of the land market in Ukraine as of III quoter 2022

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.

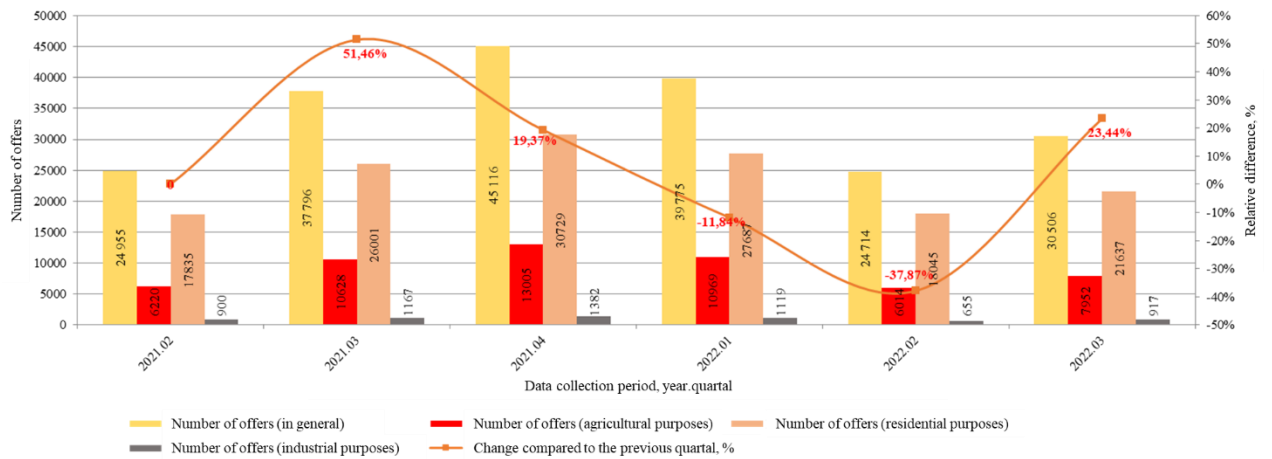


Fig. 2.2. Dynamics of the number of offers on the land market in Ukraine, 2021-2022

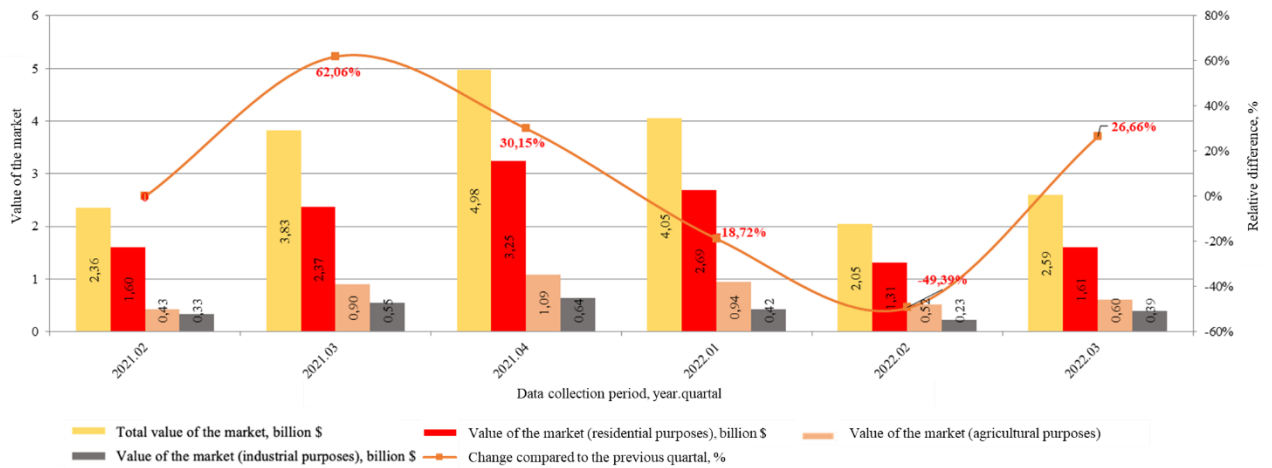


Fig. 2.3. Dynamics of the value of the land market in Ukraine, 2021-2022

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.

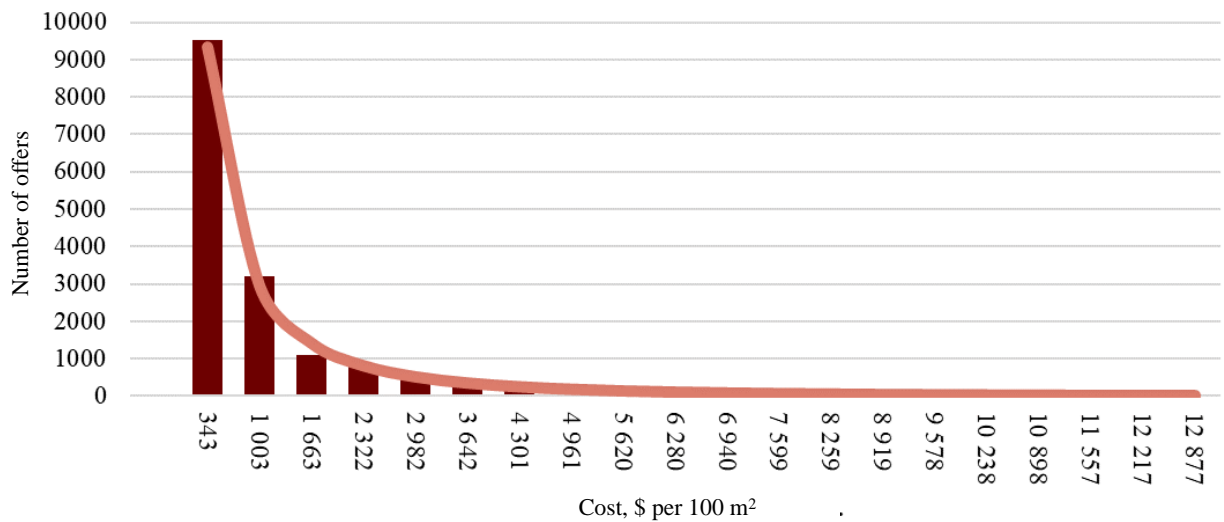


Fig. 2.4. Density distribution cost of 1 m² on the land market of Ukraine as of September 2022

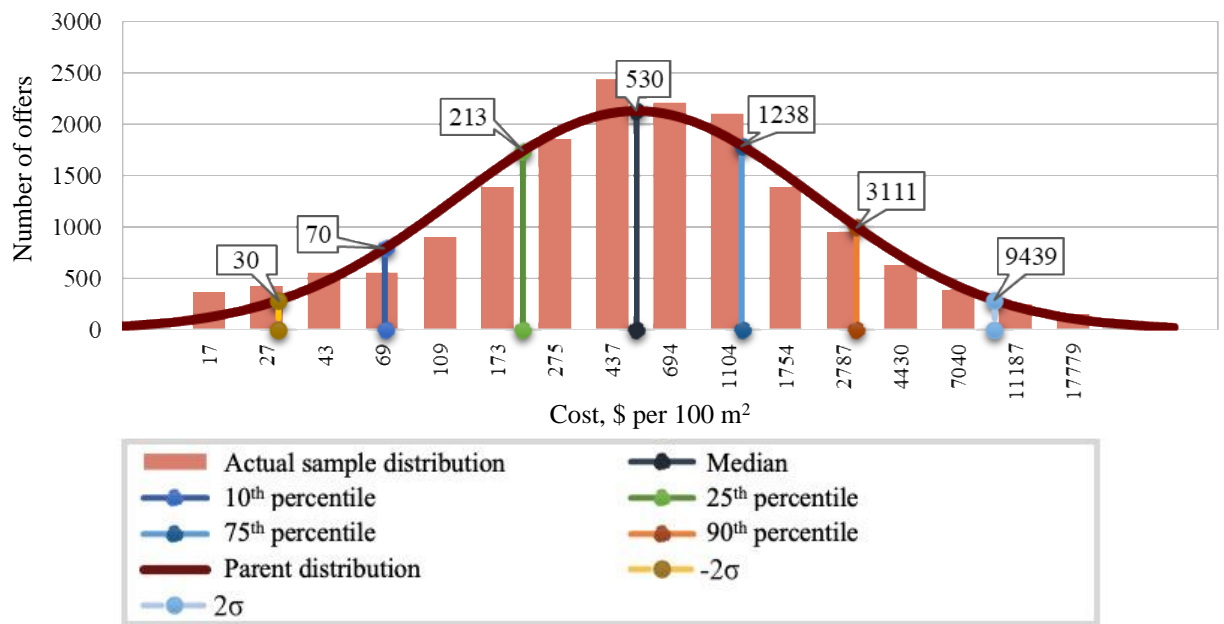
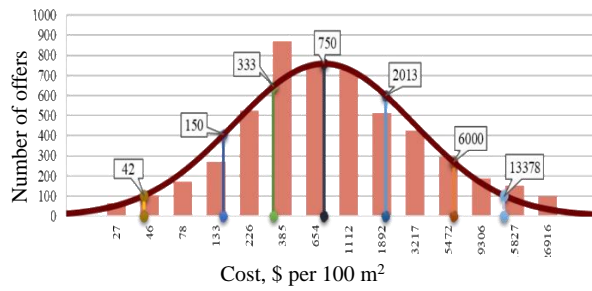
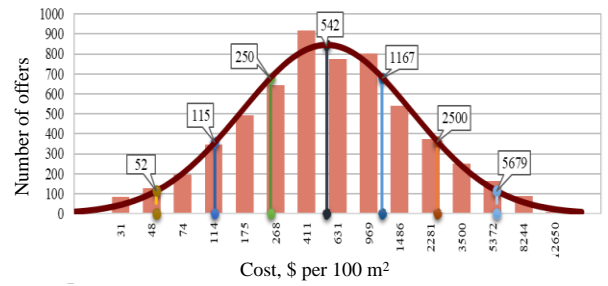


Fig. 2.5. Description of the density distribution of the cost of 1 m² on the land market of Ukraine as of September 2022 according to the log-normal distribution law

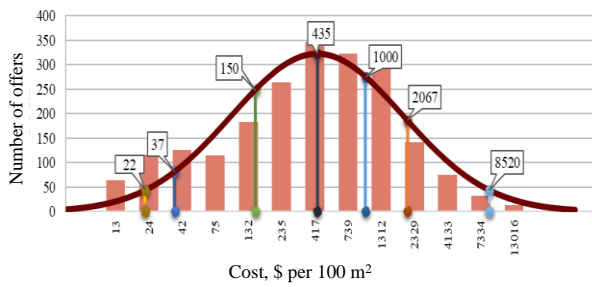
Checking the validity of this conclusion for a large number of statistical samples for separate regions and different time intervals confirmed its reasonableness (Fig. 2.6).



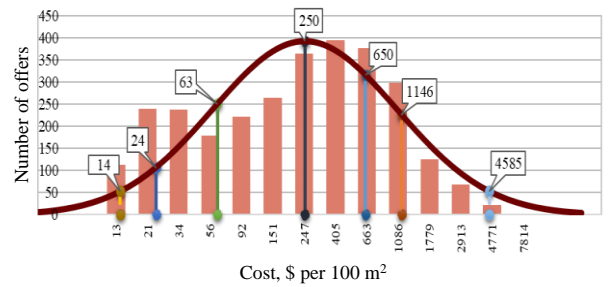
Land plots for residential buildings, central agglomerations. Cost: \$ per 100 m²



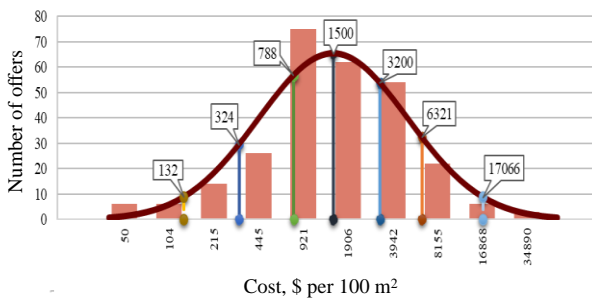
Land plots for residential buildings, periphery. Cost: \$ per 100 m²



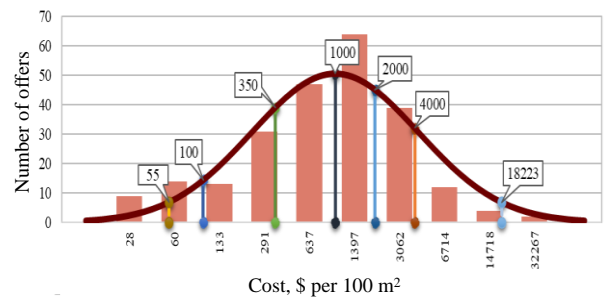
Agricultural plots of land, central agglomerations. Cost: \$ per 100 m²



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

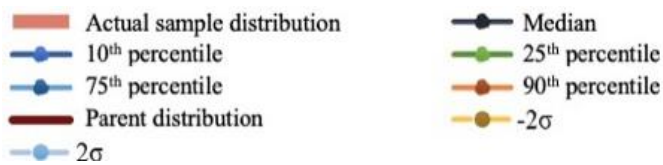


Fig. 2.6. Description of the density of the distribution of the cost of 100 m² land on the market of Ukraine depending on the type of land use and geographical cluster as of September 2022 according to the log-normal distribution law

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 2σ " 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 September 2022

Region	Amount of offers	Median (μ)	Average	$S_{lg}(\sigma)$	Coefficient of variations	Lower confidence limit interval	Upper confidence limit interval
Chernihiv region	181	267	427	0,4440	75,80%	35	2061
Kirovohrad region	118	300	582	0,5513	100,66%	24	3799
Sumy region	114	300	578	0,4926	86,51%	31	2899
Poltava	345	353	779	0,5295	95,25%	31	4044
Cherkasy region	260	393	850	0,5440	98,82%	32	4809
Zhytomyr region	430	417	700	0,4902	85,97%	44	3983
Rivne region	416	452	808	0,4681	81,02%	52	3902
Volyn region	451	477	718	0,4619	79,65%	57	4005
Khmelnitskyi region	328	490	1048	0,5154	91,85%	46	5258
Vinnitsia region	620	533	1296	0,5415	98,21%	44	6457
Zaporizhzhia region	176	590	897	0,4352	73,95%	80	4381
Kyiv region	2579	600	1591	0,5793	107,97%	42	8646
Kharkiv region	166	615	1160	0,4770	82,98%	68	5531
Dnipropetrovsk region	686	619	1481	0,5876	110,19%	41	9260
Mykolaiv region	119	636	1036	0,4382	74,56%	85	4787
Ternopil region	340	643	1109	0,4198	70,75%	93	4445
Chernivtsi region	270	694	1239	0,5490	100,08%	55	8692
Lviv region	1217	714	1353	0,4953	87,13%	73	6989

Transcarpathian region	520	800	1241	0,4647	80,25%	94	6799
Ivano-Frankivsk region	594	806	1401	0,5487	100,00%	64	10088
Donetsk region	19	957	1405	0,6444	126,55%	49	18610
Luhansk region	7	1300	1512	0,3243	52,34%	292	5788
Odesa region	1179	1500	7467	0,7935	180,60%	39	57943
Kherson region	27	1500	2760	0,4239	71,60%	213	10567

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

Region	Amount of offers	Median (μ)	Average	S_{lg} (σ)	Coefficient of variations	Lower confidence limit interval	Upper confidence limit interval
Donetsk region	6	46	105	0,4880	85,45%	5	434
Kirovohrad region	72	50	184	0,5629	103,64%	4	668
Chernihiv region	134	93	259	0,6296	122,10%	5	1680
Cherkasy region	153	100	333	0,6190	119,01%	6	1730
Poltava	226	105	317	0,6132	117,34%	6	1764
Kharkiv region	54	134	293	0,6528	129,13%	7	2700
Dnipropetrovsk region	281	135	485	0,6925	142,02%	6	3276
Sumy region	51	136	446	0,7012	144,99%	5	3427
Luhansk region	5	167	169	0,4406	75,07%	22	1268
Zaporizhzhia region	66	200	413	0,5466	99,48%	16	2479
Zhytomyr region	161	200	341	0,5144	91,61%	19	2142
Khmelnyskyi region	201	247	489	0,5593	102,73%	19	3246
Volyn region	152	300	439	0,4688	81,16%	35	2598
Rivne region	141	344	539	0,4437	75,72%	45	2652
Vinnysia region	268	362	715	0,6095	116,28%	22	5992
Odesa region	292	365	1575	0,7962	181,78%	9	14268
Ternopil region	141	372	588	0,5196	92,84%	34	4072
Kyiv region	1102	440	957	0,5902	110,91%	29	6659
Transcarpathian region	289	479	720	0,4920	86,38%	50	4614

Chernivtsi region	130	493	597	0,5263	94,45%	44	5564
Mykolaiv region	17	500	580	0,5273	94,71%	44	5669
Lviv region	589	600	953	0,5394	97,69%	50	7195
Ivano-Frankivsk region	395	600	866	0,5304	95,45%	52	6901
Kherson region	3	833	1129	0,2973	47,51%	212	3276

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

Region	Amount of offers	Median (μ)	Average	$S_{lg}(\sigma)$	Coefficient of variations	Lower confidence limit interval	Upper confidence limit interval
Mykolaiv region	4	144	334	0,6869	140,14%	6	3414
Chernihiv region	5	162	766	0,8913	228,66%	3	9818
Zaporizhzhia region	5	265	1114	0,6281	121,66%	15	4774
Kirovohrad region	8	336	757	0,8895	227,64%	6	20184
Volyn region	26	395	1030	0,6625	132,17%	19	8351
Poltava	6	445	717	0,7166	150,40%	16	12072
Zhytomyr region	12	571	1013	0,4551	78,16%	70	4646
Ternopil region	19	650	1107	0,5161	92,00%	60	6999
Odesa region	43	2500	6188	0,5960	112,49%	161	38891
Kharkiv region	3	790	2064	0,5663	104,52%	58	10713
Khmelnyskyi region	19	857	1432	0,5293	95,18%	75	9807
Rivne region	19	909	1198	0,5345	96,48%	78	10658
Chernivtsi region	7	1000	2200	0,6931	142,21%	41	24331
Cherkasy region	13	1026	1268	0,7056	146,52%	40	26454
Dnipropetrovsk region	34	1046	2147	0,5199	92,93%	95	11471
Ivano-Frankivsk region	21	1175	1814	0,5904	110,96%	77	17815
Kyiv region	155	1200	1866	0,5276	94,78%	106	13626
Vinnitsia region	15	1333	1845	0,8367	200,30%	28	62844

Lviv region	65	1500	2107	0,5374	97,19%	126	17822
Transcarpathian region	21	1500	1901	0,3810	63,00%	259	8672

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.

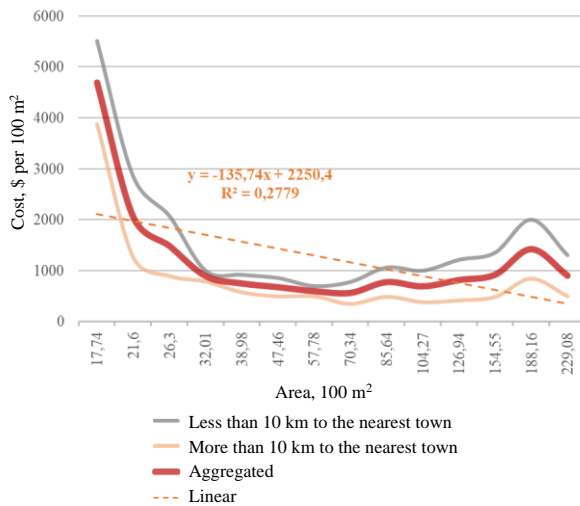


Fig. 2.7. Dependence of the value of 100 m² of residential land holdings on their total area (Central agglomerations)

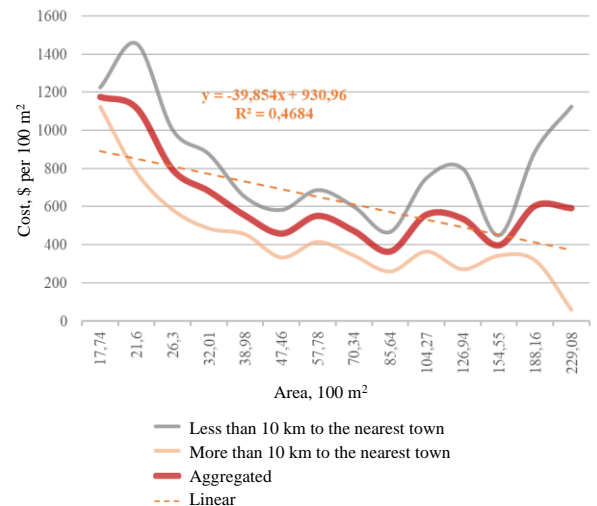


Fig. 2.8. Dependence of the value of 100 m² of residential land holdings on their total area (Periphery)

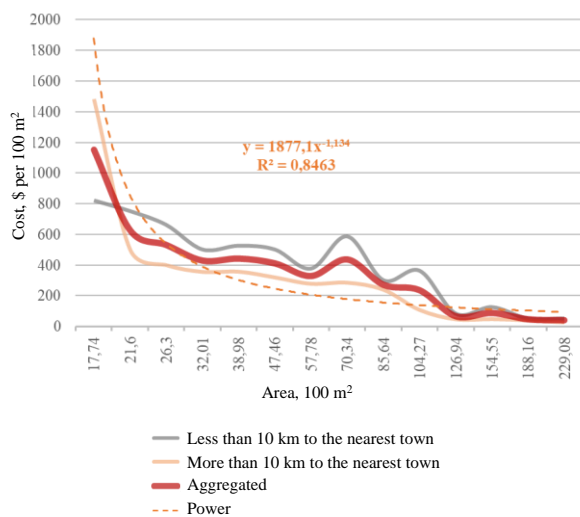


Fig. 2.9. Dependence of the value of 100 m² of agricultural land plots on their total area

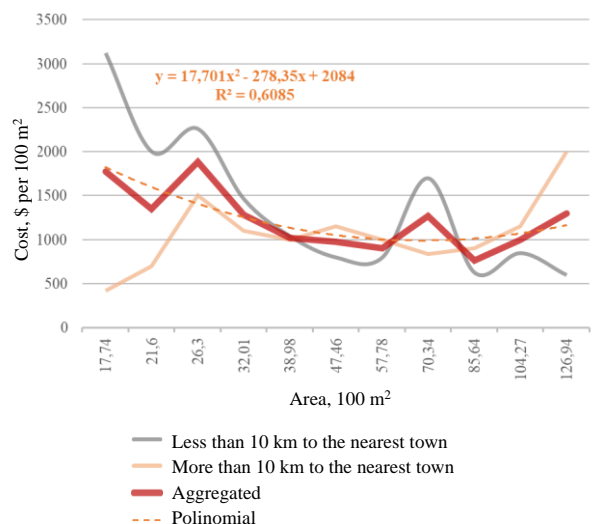


Fig. 2.10. Dependence of the value of 100 m² of industrial land holdings on their total area

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	Central agglomerations *	Up to 10 km	In general	1006,64	0	0%
			Up to 2500 m ²	1000	-7	-1%
			More than 2500 m ²	1100	93	9%
		From 10 to 50 km	In general	525	0	0%
			Up to 2500 m ²	544,525	20	4%
			More than 2500 m ²	454,55	-70	-13%
	Periphery	Up to 10 km	In general	666,67	0	0%
			Up to 2500 m ²	680	13	2%
			More than 2500 m ²	627,935	-39	-6%
		From 10 to 50 km	In general	348,24	0	0%
			Up to 2500 m ²	360	12	3%
			More than 2500 m ²	325	-23	-7%
Agricultural plots of land	Central agglomerations *	Up to 10 km	In general	600	0	0%
			Up to 2500 m ²	759,23	159	27%
			More than 2500 m ²	400,94	-199	-33%
		From 10 to 50 km	In general	312,5	0	0%
			Up to 2500 m ²	442,435	130	42%
			More than 2500 m ²	167,92	-145	-46%
	Periphery	Up to 10 km	In general	366,67	0	0%
			Up to 2500 m ²	500	133	36%

		More than 2500 m ²	200	-167	-45%
	From 10 to 50 km	In general	200	0	0%
		Up to 2500 m ²	333,27	133	67%
		More than 2500 m ²	74,265	-126	-63%

* 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, 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.

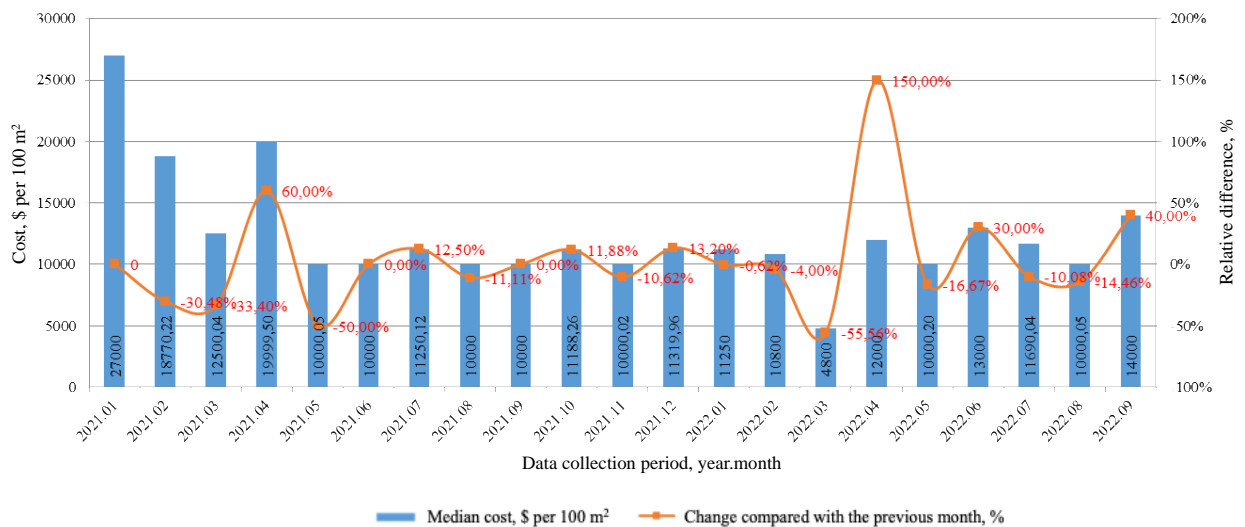


Fig. 2.11. The dynamics of changes in the median value of the price per 100 m² of land holdings on the land market in Ukraine in 2021-2022.

3. INFORMATION AND ANALYTICAL UNIT OF THE HOUSEHOLD MARKET

As of the end of September 2022, the total information base of the home ownership market is more than 28,000 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 5.5 billion dollars. USA (Fig. 3.1).

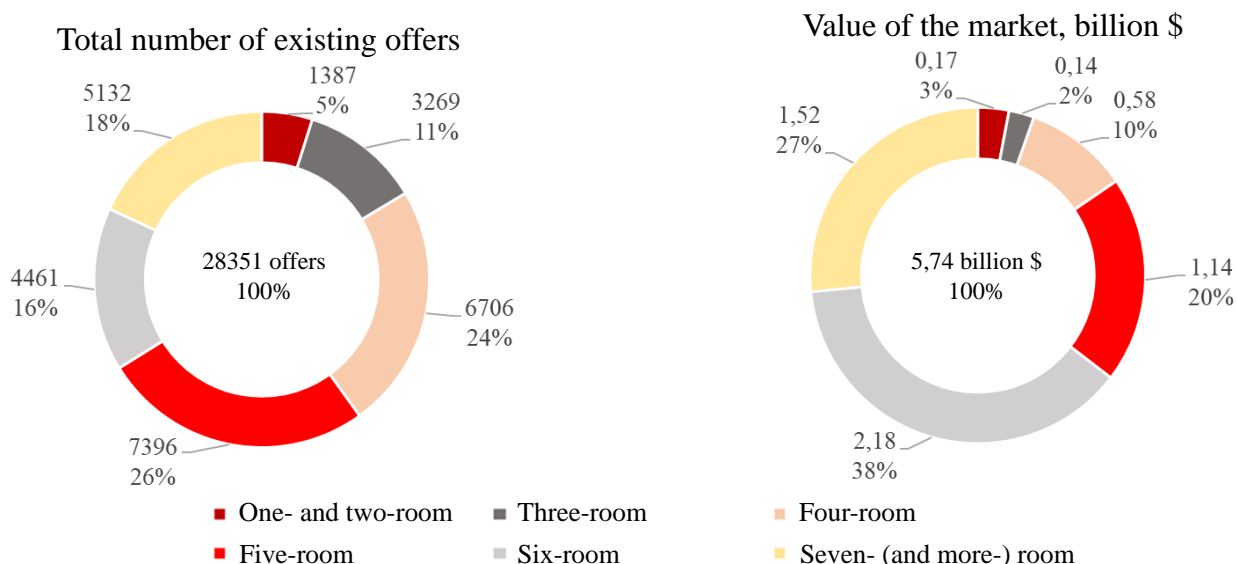


Fig. 3.1. Volume of the household market in Ukraine as of September 2022

The total number of existing offers for sale in the first half of 2022 amounted to 28351 home ownerships (Fig. 3.1). The largest share of offers for sale falls on five- and four-room houses, which for them is 26% and 24% of the total number of apartments offered for sale, respectively. For six- and seven-room offers, this share is also significant, reaching 16% and 18%, respectively. Thus, 16% 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 September amounted to more than 12.70 billion dollars. USA (Fig. 3.1). The largest share in it falls again on six- and seven-room offers - 38% and 27%, respectively, while five-room - 20%. The share of 4-room apartments in monetary terms is already 10%, 1-, 2-, and 3-room apartments, respectively, 5%.

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.

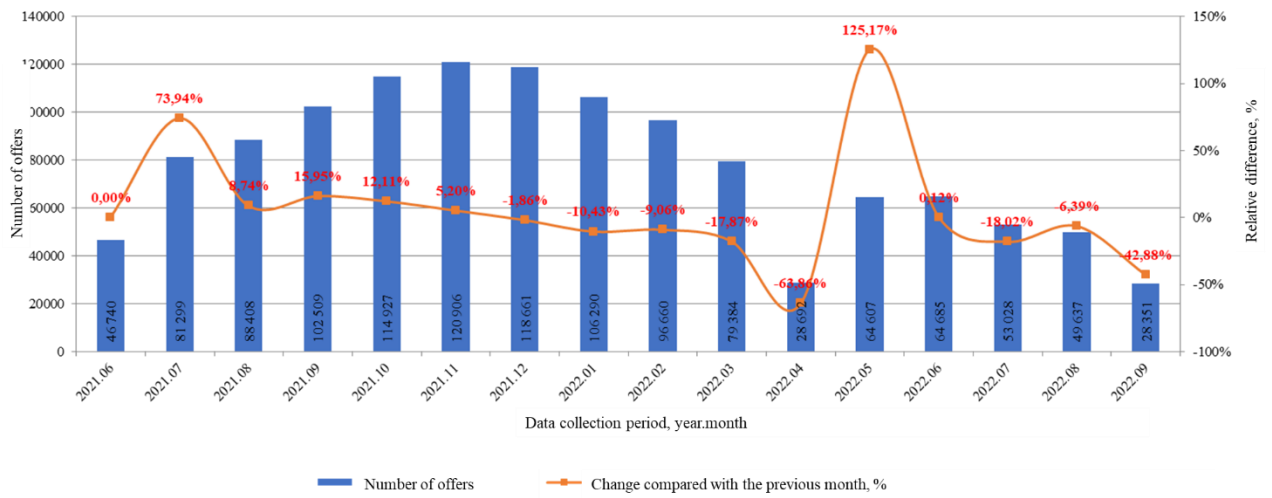


Fig. 3.3. Dynamics of the number of offers on the secondary household market in Ukraine, 2021-2022

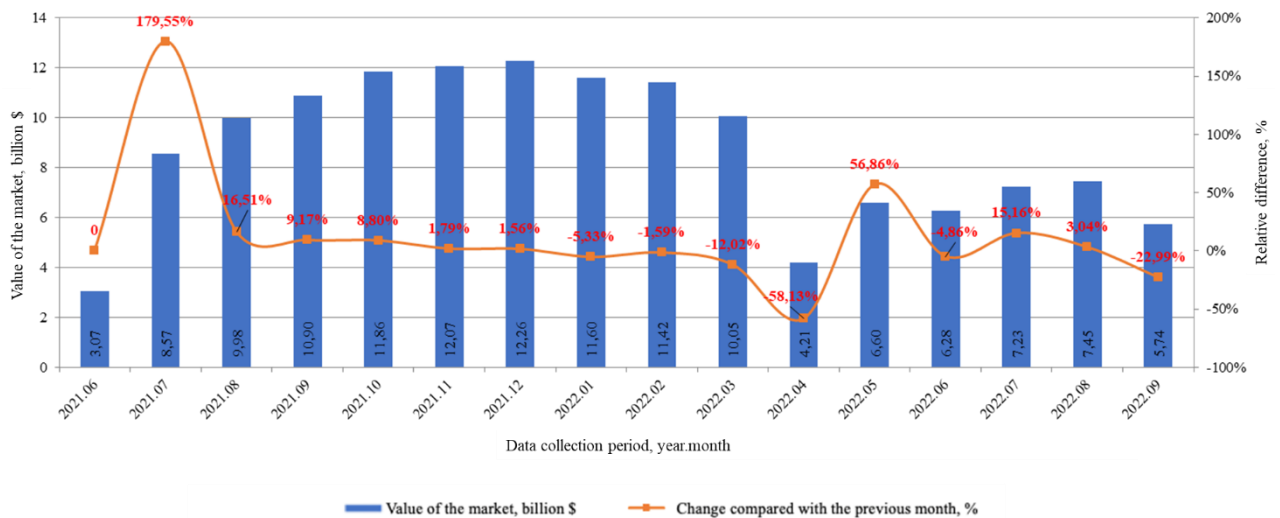


Fig. 3.4. Dynamics of the value of the secondary household market in Ukraine, 2021-2022

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).

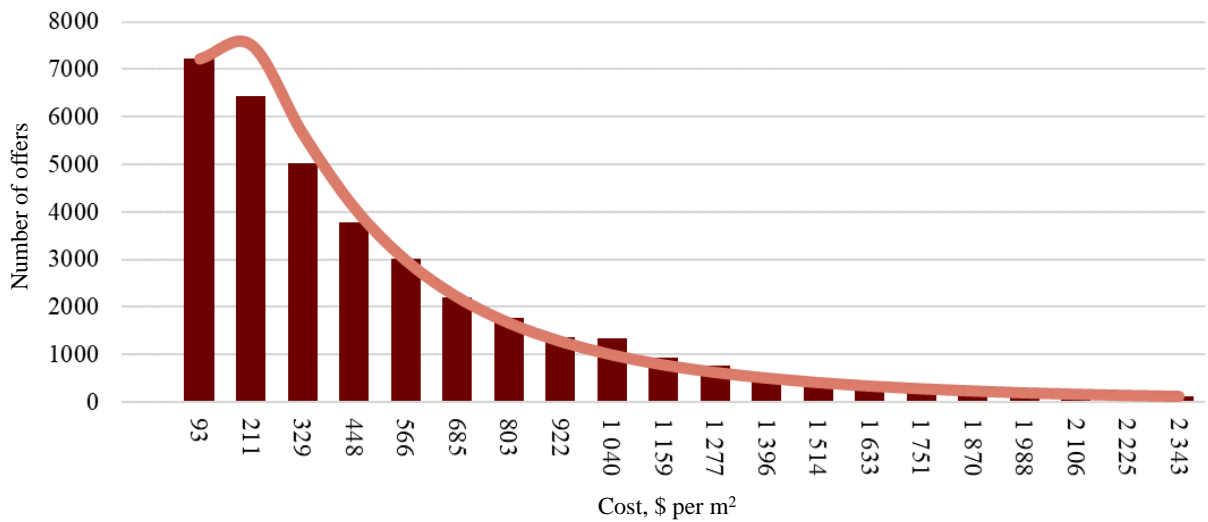


Fig. 3.4. Density distribution cost of 1 m² on the secondary household market of Ukraine as of September 2022

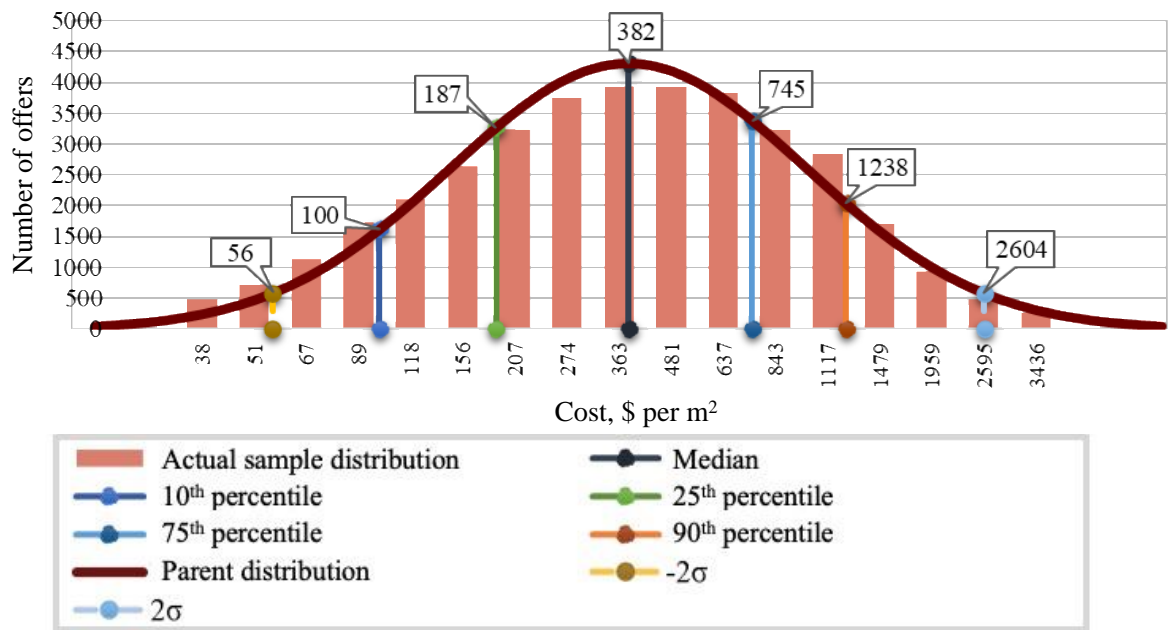
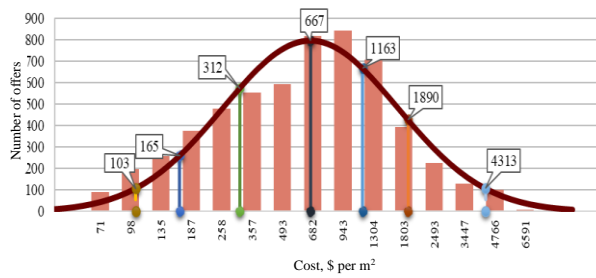
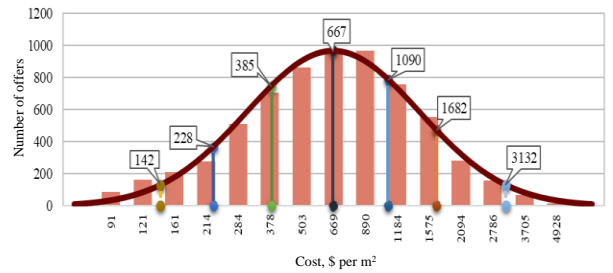


Fig. 3.5. Description of the density distribution of the cost of 1 m² on the secondary household market of Ukraine as of September 2022 according to the log-normal distribution law

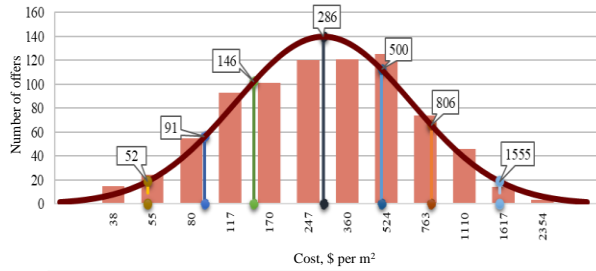
Thus, compliance with the log-normal distribution law is confirmed for all considered categories of real estate, including apartments, land plots of any purpose, and home ownership. This opens up the possibility of applying a single methodology for processing the primary information database for these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



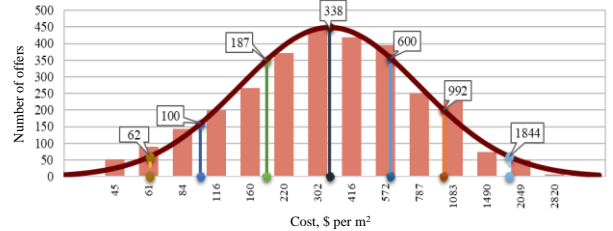
Kyiv region. Cost: $\$/m^2$



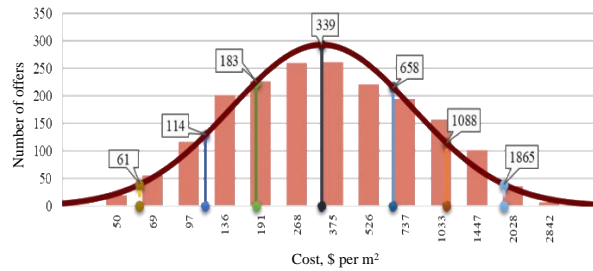
Odesa region. Cost: $\$/m^2$



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



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



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

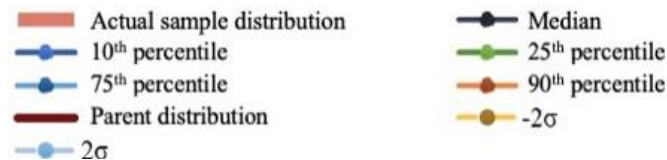


Fig. 3.6. Description of the density of the distribution of the cost of 1 m² of householdings on the secondary market of the largest cities of Ukraine as of September 2022 by the log-normal distribution law

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 September 2022

Region	Amount of offers	Median (μ)	Average	$S_{lg}(\sigma)$	Coefficient of variations	Lower confidence limit interval	Upper confidence limit interval
Vinnytsia region	1189	477	574	0,3704	60,96%	87	2626
	485	167	223	0,3340	54,11%	36	776
Volyn region	214	446	490	0,3026	48,44%	111	1798
	101	167	244	0,3230	52,12%	38	738
Dnipropetrovsk region	1684	392	510	0,3268	52,80%	87	1768
	619	245	390	0,4051	67,76%	38	1582
Donetsk region	198	229	274	0,3076	49,33%	56	944
	6	267	306	0,4178	70,34%	39	1827
Zhytomyr region	531	320	410	0,3260	52,66%	71	1436
	385	146	203	0,3134	50,37%	35	620
Transcarpathian region	752	545	655	0,2845	45,26%	147	2022
	276	292	361	0,2564	40,42%	90	951
Zaporizhzhia region	368	503	587	0,2958	47,25%	129	1962
	148	200	301	0,3530	57,64%	39	1016
Ivano-Frankivsk region	630	417	507	0,3130	50,30%	99	1761
	264	250	309	0,2894	46,12%	66	948
Kyiv region	2225	712	856	0,3458	56,30%	145	3499
	2415	680	1038	0,4426	75,50%	89	5221
Kirovohrad region	399	271	336	0,3487	56,83%	54	1349
	168	116	150	0,3280	53,02%	26	524
Luhansk region	139	211	261	0,2505	39,42%	66	667
	4	173	173	0,1278	19,57%	96	311
Lviv region	920	460	608	0,3548	57,98%	90	2355
	448	223	337	0,3416	55,52%	46	1077
Mykolaiv region	183	234	321	0,3334	54,02%	50	1086
	132	113	173	0,3432	55,82%	23	550
Odesa region	3962	816	1001	0,3165	50,93%	190	3507
	1417	478	577	0,3096	49,70%	115	1987
Poltava	663	336	420	0,3373	54,73%	71	1589
	452	140	187	0,3291	53,22%	31	636
Rivne region	555	431	552	0,3026	48,45%	107	1736
	264	213	272	0,3005	48,08%	53	848
Sumy region	246	218	293	0,3705	60,98%	40	1203
	106	85	124	0,3292	53,25%	19	385
Ternopil region	505	298	352	0,2917	46,52%	78	1142
	244	167	211	0,2815	44,74%	46	609
Kharkiv region	362	444	501	0,3336	54,04%	96	2065
	253	219	275	0,3393	55,10%	46	1043
Kherson region	390	600	669	0,2137	33,30%	224	1605
	20	371	443	0,2786	44,24%	103	1340
	674	337	425	0,3354	54,38%	72	1579

Khmelnyskyi region	316	145	197	0,3506	57,19%	29	727
Cherkasy region	693	266	388	0,3949	65,73%	43	1637
	584	124	184	0,3506	57,20%	25	624
Chernivtsi region	380	467	551	0,3222	51,97%	106	2057
	205	214	277	0,3055	48,96%	52	875
Chernihiv region	324	208	265	0,3136	50,41%	49	883
	329	100	133	0,3045	48,79%	25	406

 Up to 10 km

 From 10 to 50 km