

Analysis of the Real Estate Market in Burgas, Bulgaria, during the COVID-19 pandemic

MARIN MARINOV, IVO DRAGANOV
Technical University of Sofia,
8 Kliment Ohridski Blvd., Sofia, 1756
BULGARIA

Abstract: In this paper is presented an analysis on the change of the prices and their distribution of the real estates in the city of Burgas. The analysis period covers the years 2019 through 2021, including the time of the COVID-19 pandemic. Apart from the change on a quarter year basis the prices are investigated with their statistical distributions and clustering is being performed on the price class of 1-, 2- and 3- bedroom apartments. The results are useful tool for broker houses to perform adequate offering of real estates in the region with attractive marketing to their clients. The overall change over time of the living areas as a price per square meter could be used for future prediction of their values, which will further enhance the offering process and finding proper clients.

Keywords: real estate, market analysis, Burgas, Bulgaria, pandemic, COVID-19.

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1. Introduction

THE development of the real estate market in Bulgaria and Poland has been thoroughly investigated by Racka et al. [1]. They diagnose the specificity of the residential segment and the accompanying transformation processes, accounting for the real GDP growth rate of 0.9 or 39.9 billion EUR in 2015 or Bulgaria. The average household size in degree of urbanization is estimated to 2.45 in densely populated area such as the city of Burgas in 2010. The median housing cost burden change had a significant drop in the years 2009 and 2010 from 22% to around 14% and then increased to about 20% for the years 2012 and 2013. Some of the factors that are being investigated on the revitalization of the public domain in Bulgaria are summarized in the studies of Kostov et al. [2]. The authors include in their analysis the current state of local streets, the public parking condition as well as the green areas. Administrative units such as health, educational and cultural centers are also taken into account along with the public transportation system. One of the major efforts towards making the real estate in large cities more wanted was a dedicated project of improving the infrastructure comprising of BGN 9 278 247.39 in the period 2011-2015.

The eastern part of Bulgaria in terms of real-estate distribution and public demand has been studied by Racka and Ivo [3]. The average residential price per unit changed from 758 EUR in 2015 to 936 in 2017 for the city of Varna. There was considerable difference between the average growth of the prices of realized deals of about 5%, compared to 10% increase in the offering. One of the major conclusions of the authors is that the national trend of the Bulgarian economy is not convergent and differs from the local trend. That is a serious reason to investigate local markets of real estate in

some of the major cities, such as Burgas, within the country.

Interesting approach is presented in [4] by Bobeva et al. In that paper an early warning system is developed for the market of real estates in Bulgaria. Sectoral crisis indicators are generated, starting with the residential prices, which are gathered in a composite index. Time-varying thresholds are found for detection of the fast changing residential rates, which once again points out the necessity of close look over the prices in time. Multiple crisis situations has been found from the year 2000 to 2019 in the Bulgarian residential market this way. It would be important to put into this model the results of analyzing the price change for the real estates in the case of Burgas.

Another interesting correlation between the housing prices and the REIT index is studied by Petrova [5] with searching an effect on the Bulgarian stock exchange index. That investigation discovered smooth follow up between the SOFIX and the average dwelling price for the period 2001-2007, starting from around 100 to over 1500. Closer look at the housing prices is also a necessity for such kind of correlation analysis.

Castelli et al. [6] prove that the Lasso regression is the appropriate tool when predicting the days on the market when comes the phase to optimize the residential sales strategy. The authors try also the Ridge method, Elastic Net and an Artificial Neural Network. While the loans interest rates in Bulgaria show global decline from 2000 to 2018 with a few periods of oscillations, the amount of home loans reveal significant drop from 2008 to 2009. Then, from 2009 to 2014 it stays almost unchanged and constantly rise from 2015 to 2018. Again, an interesting tendency would be to monitor the real estate market in the period of COVID-19 pandemic.

Some real estate agencies are investigated by Ignatova [7] for the period of 2012-2015 on the basis of internal and external core capital, and fixed intangible assets. For 2015 the

efficiency on the grounds of the total capital, related to residential properties, varies between 91% and 242%. It is different from the change of the internal and the external core capital. Interestingly, it is worth the effort to find a correlation between these changes and the current residential prices.

The overall behavior of the real estate agencies has been put within the framework of a regulation which has been studied by Tomova [8]. It is based on the European standard for the services of the residential brokers. The amount of the commission fee must be part of the contract when making deals and thus in most of the cases it depends on the price of the real estate. Yet, it is another reason for the closer look of the real estate market situation in the various regions of the country.

2. Data Preprocessing

The preliminary processing of the raw data with the prices of the real estates is given below:

1. Data separation:
 - a. The raw Data is gathered by hand and saved in Excel files. It is the monthly prices of the residential units from January 2019 to December 2021.
 2. Data cleaning – an efficient C# tool is compiled for removing empty entries and non-significant rows from the 34 Excel files are also removed.
 - a. Then the ordered Data from the Excel tables with initially cleaned rows and columns is loaded into specialized phase based MS SQL Server database. It is organized again in tables. Every phase table by definition poses all the components of the data – city, district, the average total price and the price per square meter for 1-, 2- and 3-bedroom apartments.
 - b. Following the initial organization, a transformation follow on a monthly basis in the form of time series. The newly organized time series in the phasing tables are sequentially ordered, including the city name, the average n -th bedroom real estate, the district and the month by month price in EUR.

c. Stage of aggregating the data by quarters of the year
Further transformation of the data happens in the same tables by the usage of visual database objects, so no new records are being entered in the database. Common definition is used for the purpose, which includes averaging of the prices by three months in sequential order, preserving the labels of the city and the respective district. Proper labels are being given to the new values in the table.

3. Datamart filling with the Transformed Data

The function of a Datamart plays the Excel table, where the

fully transformed data is gathered and then the following analysis could take place.

3. Experimental Results

We use publicly available dataset with the real estate prices for the investigated period [11]. Timeseries by quarters of the year for one-, two-, three- and all-bedroom apartments in the city of Burgas with 13 of its districts are presented in Fig. 1-4. The prices are given in EUR/m². The families of curves cover the period from the beginning of 2019 to the end of 2021. Thus, the analysis includes a year prior the emerge of the COVID-19 pandemic and the time frames of the strict lockdowns during it. In 2021, although there were no complete lockdowns, major facilities underwent activities in a remote fashion, so this period is also of interest for analysis.

The average (mean, Av), the median (Med) and standard deviation (St. Dev.) values of the price by year and a neighborhood are given in Table I. These are the first and second order statistical moments. From the time series, shown on Fig. 4 the discrete distributions of the prices for all-bedroom apartments by year become available (Fig. 5-7). They are colored in green and in orange are the continuous distributions approximations, derived from them. The related mathematical operations are carried out in the environment of the XLSTAT software [11].

According to recommendations in [12] the significance level is set to 5%. It allows to find the most relevant distribution among the most popular types. They are ordered in Table II. The most appropriate distribution is found by the maximum likelihood method. The level of convergence for all tried cases is 0.00001.

The estimated parameters for the Weibull (2) distribution (Fig. 5) are: $\beta = 4.451 \pm 0.852$, and $\gamma = 869.320 \pm 0.603$. The log-normal distribution (Fig. 6) possesses the following defining parameters: $\mu = 6.550 \pm 0.048$ and $\sigma = 0.258 \pm 0.051$. The distribution with the Beta4 approximation (Fig. 7) gives $\alpha = 0.571 \pm 0.069$, $\beta = 0.613 \pm 0.052$, $c = 480.869$ and $d = 1024.328$. Table III presents the Log-likelihood (LL) statistics, the Bayesian Information Criterion (BIC) and the Akaike Information Criterion (AIC) given the three distributions from above.

Table IV presents the statistical parameters that are directly computed from the aggregated data and those from the approximating distributions. Pearson criterion is used when finding the Skewness and the Kurtosis parameters from the continuous distributions.

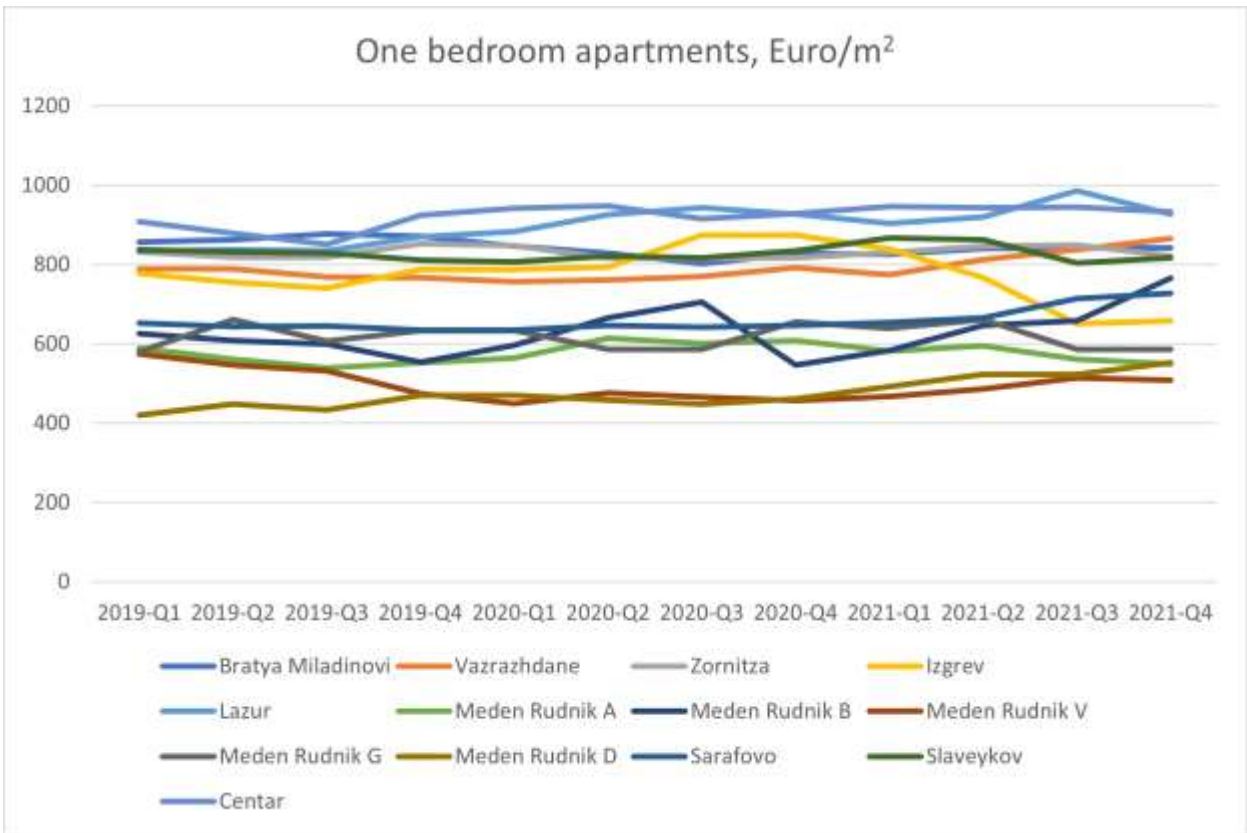


Fig. 1 One bedroom apartments price change from 2019 to 2021



Fig. 2 Two bedroom apartments price change from 2019 to 2021



Fig. 3 Three bedroom apartments price change from 2019 to 2021



Fig. 4 All apartments price change from 2019 to 2021

Table V contains the parameters from the Kolmogorov-Smirnov test, applied over the three distributions. These values are the proof of the correctness of the built hypotheses about the approximating distributions (Fig. 5-7).

TABLE I
 MEAN, MEDIAN AND VARIANCE OF THE REAL ESTATE PRICE

Clusters	2019			2020			2021		
	Av.	Me d.	St. Dev	Av.	Me d.	St. Dev	Av.	Me d.	St. Dev
Bratja Miladinovi	942,25	835,5	226,82	868,75	871,5	7,37	904,75	904,5	13,23
Vazrazhdane	863,75	768,5	192,17	781	780	3,83	799,25	800,5	7,76
Zornitza	1073	950	248	976	977	6,06	1019	1024,5	32,69
Izgreve	818	719,5	200,02	754	749,5	13,74	772	773,5	11,52
Lazur	1034,75	912	250,95	949,25	950	1,5	950	950	0
Meden Rudnik A	603,25	536	135,17	542,25	540	5,25	545,25	543	9
Meden Rudnik B	587,5	533	114,44	533,75	540	16,09	546,75	535	24,85
Meden Rudnik V	504,75	457	108,69	462,5	463	10,63	486,25	482,5	18,95
Meden Rudnik G	543	513,5	94,26	502,75	509,5	32,36	494	496,5	15,03
Meden Rudnik D	664	604,5	128,39	576,25	571	11,9	567,5	567	2,65
Sarafovo	750,25	669	169,93	676,25	675	7,27	722,75	721	32,56
Slavejkovo	839	748,5	186,71	765,75	765,5	9,81	776,75	777	0,5
Centar	1124,5	995,5	259	1008,75	1008,5	6,85	1012	1012,5	4,97

All the *c* curves from Fig. 4 were approximated one by one with the use of linear regression in order to find the overall change of the prices in every neighborhood. The general equation for a linear trend appears to show that change, according to:

$$y = mx + c, \tag{1}$$

In (1) *x* is the temporal period of 3 months and changes over time, *y* – approximated price, *m* – the slope of the approximating line, *c* – a free component. All the lines with their *m* and *c* together with their precision are presented in Table VI. The linear approximation was done with the MyCurveFit [12] application.

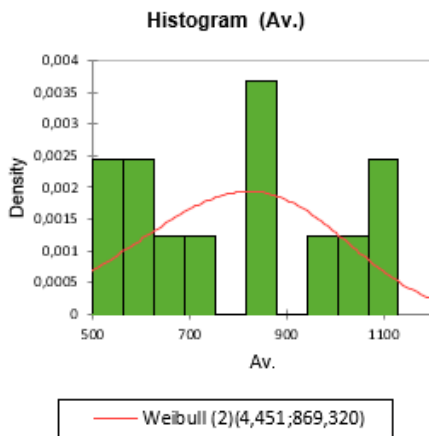


Fig. 5. All apartments price distribution for 2019

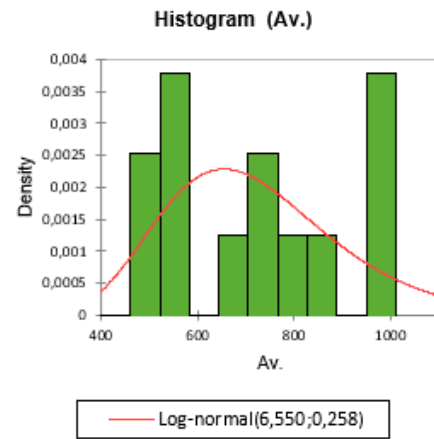


Fig. 6. All apartments price distribution for 2020

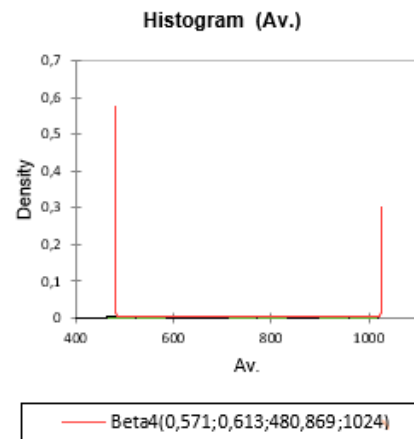


Fig. 7. All apartments price distribution for 2021

The accuracy of the linear regression for each case is measured with the following parameters: R^2 (R^2 measure), aR^2 (Adjusted R^2 value), *P* (P-value), *SE* (Standard Error), and *F* (*F*-statistic), shown in Table VII.

TABLE II
 P-VALUES FOR ALL TRIED DISTRIBUTIONS OVER ALL APARTMENTS

Distribution	2019	2020	2021
Beta4	-	-	0,960
Chi-square	0,014	0,005	0,004
Erlang	0,726	0,695	0,785
Exponential	0,004	0,003	0,003
Fisher-Tippett (1)	<0,0001	<0,0001	<0,0001
Fisher-Tippett (2)	0,910	0,801	0,692
Gamma (1)	-	<0,0001	<0,0001
Gamma (2)	0,935	0,822	0,622
GEV	0,833	0,481	0,564
Gumbel	<0,0001	<0,0001	<0,0001
Log-normal	0,941	0,852	0,644
Logistic	0,953	0,808	0,632
Normal	0,929	0,767	0,590
Student	<0,0001	<0,0001	<0,0001
Weibull (2)	0,962	0,813	0,642

In order to group the various real estates by price in all neighborhoods K-means clustering is performed. It is initialized with the K-means++ algorithm. Totally 10 reruns are needed for the purpose, while in the same time there is period limitation of the calculations to 300 steps.

TABLE III
 LOG-LIKELIHOOD STATISTICS

Parameter	Weibull (2)	Log-normal	Beta4
LL	-87,274	-86,009	-80,185
BIC	179,677	177,148	170,630
AIC	178,547	176,018	168,370

All numerically implemented steps are done with the Orange v.3.28 application [13]. The number of clusters is varied between 2 and 8 and an optimal number is found in each run. That number by neighbourhood could be seen in Table VIII. The groupings were estimated by type of apartment – 1-, 2- and 3-bedroom, respectively, in each of the studied years. The optimal number of clusters is found by the maximum Silhouette score obtained during the calculation.

TABLE IV
 ACTUAL AND PREDICTED DATA STATISTICS

Distribution	Weibull (2)		Log-normal		Beta4	
	Data	Predicted	Data	Predicted	Data	Predicted
Mean	796,000	792,811	722,865	723,248	738,173	743,010
Variance	43244,36	40765,88	36068,67	36101,01	38261,77	33757,482
Skewness	0,122	-0,170	0,116	0,806	0,076	0,066
Kurtosis	-1,514	-0,199	-1,603	1,178	-1,644	-1,429

TABLE V
 KOLMOGOROV-SMIRNOV TEST PARAMETERS

Distribution	Weibull (2)	Log-normal	Beta4
D	0,129	0,158	0,130
p-value	0,962	0,852	0,960
Alpha	0,050	0,050	0,050

TABLE VI
 LINEAR REGRESSION PARAMETERS BY NEIGHBORHOOD

District	m	Δm	c	Δc
Bratja Miladinovi	8.51	0.80	814.29	5.86
Vazrazhdane	3.82	0.32	757.80	2.32
Zornitza	8.64	1.15	926.36	8.48
Izgreve	5.62	1.05	713.72	7.71
Lazur	4.15	0.94	911.72	6.88
Meden Rudnik A	1.37	0.40	532.21	2.98
Meden Rudnik B	2.30	1.54	519.94	11.36
Meden Rudnik V	4.66	1.01	435.68	7.48
Meden Rudnik G	1.82	2.21	482.47	16.27
Meden Rudnik D	-3.13	0.94	599.19	6.99
Sarafovo	7.50	1.35	639.72	9.98
Slavejkovo	3.77	0.44	738.23	3.25
Centar	1.50	0.55	996.56	4.07

TABLE VII
 ACCURACY OF THE LINEAR REGRESSION MODELS

District	R ²	aR ²	P	SE	F
Bratja Miladinovi	0.9195	0.9114	8.6202	9.5192	114.20
Vazrazhdane	0.9363	0.9299	2.6476	3.7722	147.04
Zornitza	0.8487	0.8336	2.0859	13.7880	56.10
Izgreve	0.7417	0.7159	0.0003	12.5358	28.73
Lazur	0.6640	0.6303	0.0012	11.1835	19.76
Meden Rudnik A	0.5367	0.4904	0.0067	4.8402	11.58
Meden Rudnik B	0.1821	0.1003	0.1665	18.4653	2.23
Meden Rudnik V	0.6778	0.6456	0.0010	12.1609	21.03
Meden Rudnik G	0.0638	-0.029	0.4283	26.4392	0.68
Meden Rudnik D	0.5210	0.4732	0.0080	11.3584	10.87
Sarafovo	0.7536	0.7290	0.0002	16.2226	30.59
Slavejkovo	0.8795	0.8674	6.5924	5.2807	72.98
Centar	0.4249	0.3674	0.0216	6.6137	7.3900

Visually, the clustering for all apartments by year from the different neighborhoods is shown in Fig. 8-10. For 2019 the

lowest price category corresponds to the C2 class, and the highest in price – to C1, C3 is in the middle. Analogously, the price class distribution could be observed in Fig. 9 and 10.

TABLE VIII
 SILHOUETTE SCORES FOR FINDING THE OPTIMAL NUMBER OF CLUSTERS BY TYPE OF APARTMENT

Clusters	One Room Apartments			Two Room Apartments			Three Room Apartments		
	2019	2020	2021	2019	2020	2021	2019	2020	2021
2	0.728	0.71	0.639	0.562	0.605	0.67	0.566	0.625	0.661
3	0.592	0.784	0.616	0.611	0.623	0.744	0.638	0.657	0.756
4	0.552	0.841	0.707	0.629	0.544	0.739	0.658	0.558	0.655
5	0.542	0.806	0.694	0.618	0.504	0.657	0.636	0.541	0.671
6	0.532	0.68	0.632	0.609	0.546	0.579	0.61	0.493	0.55
7	0.455	0.576	0.56	0.54	0.524	0.494	0.526	0.503	0.551
8	0.411	0.444	0.48	0.488	0.483	0.401	0.442	0.425	0.51

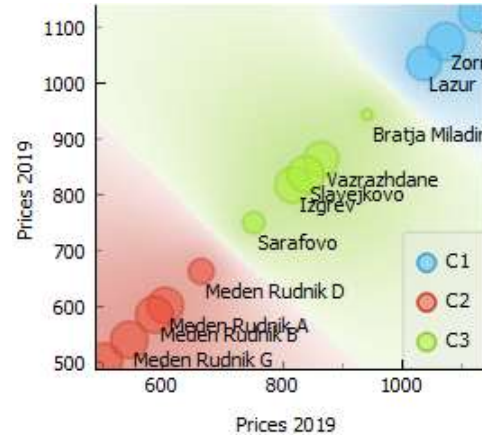


Fig. 8. All apartments clusters for 2019

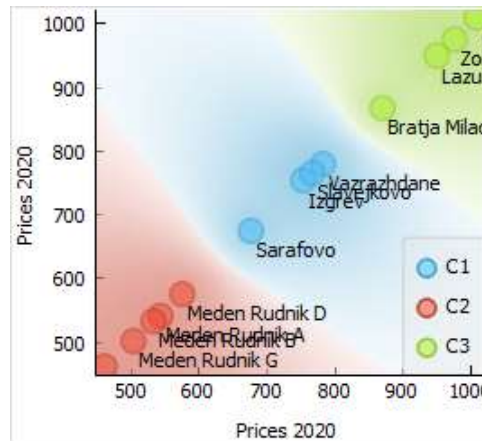


Fig. 9. All apartments clusters for 2020

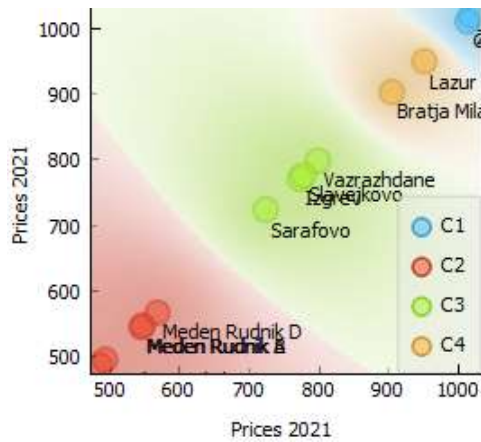


Fig. 10. All apartments clusters for 2021

Detailed distribution of the classes by category of apartment and neighbourhood is given in Tables IX-XII. In the same tables also the Silhouette scores are given for each case. The trace covers every year from 2019 to 2021.

TABLE IX
ONE BEDROOM APARTMENTS CLUSTERING

Year	2019	2019	2020	2020	2021	2021
Neighborhood	Cluster	Silhouette	Cluster	Silhouette	Cluster	Silhouette
Bratja Miladinovi	C1	0.719935	C3	0.718943	C4	0.741337
Vazrazhdane	C1	0.692881	C3	0.678107	C4	0.728217
Zornitza	C1	0.724579	C3	0.720722	C4	0.741403
Izgrev	C1	0.681315	C3	0.707384	C2	0.598302
Lazur	C1	0.724412	C1	0.727337	C1	0.736366
Meden Rudnik A	C2	0.706686	C2	0.707597	C3	0.616539
Meden Rudnik B	C2	0.699952	C2	0.730116	C2	0.685332
Meden Rudnik V	C2	0.703088	C4	0.747471	C3	0.695554
Meden Rudnik G	C2	0.678385	C2	0.728262	C2	0.54546
Meden Rudnik D	C2	0.678721	C4	0.74751	C3	0.703639
Sarafovo	C2	0.647838	C2	0.720887	C2	0.690285
Slavejkovo	C1	0.722836	C3	0.720078	C4	0.741036
Centar	C1	0.709557	C1	0.730158	C1	0.737442

TABLE X
TWO BEDROOM APARTMENTS CLUSTERING

Year	2019	2019	2020	2020	2021	2021
Neighborhood	Cluster	Silhouette	Cluster	Silhouette	Cluster	Silhouette
Bratja Miladinovi	C3	0.552966	C1	0.545017	C1	0.656361
Vazrazhdane	C1	0.669848	C1	0.677924	C3	0.699729
Zornitza	C3	0.7015	C3	0.70156	C1	0.694057
Izgrev	C1	0.707945	C1	0.707195	C3	0.721704
Lazur	C3	0.682232	C3	0.697266	C1	0.699963
Meden Rudnik A	C4	0.661687	C2	0.703331	C2	0.718013
Meden Rudnik B	C4	0.641615	C2	0.698033	C2	0.712124
Meden Rudnik V	C2	0.739687	C2	0.703667	C2	0.715502
Meden Rudnik G	C2	0.738973	C2	0.698645	C2	0.713348
Meden Rudnik D	C4	0.628324	C2	0.580569	C2	0.69093
Sarafovo	C1	0.635563	C1	0.637438	C3	0.689166
Slavejkovo	C1	0.711235	C1	0.69741	C3	0.718914
Centar	C3	0.696882	C3	0.707163	C1	0.709394

TABLE XI
THREE BEDROOM APARTMENTS CLUSTERING

Year	2019	2019	2020	2020	2021	2021
Neighborhood	Cluster	Silhouette	Cluster	Silhouette	Cluster	Silhouette
Bratja Miladinovi	C1	0.653969	C3	0.514557	C3	0.644215
Vazrazhdane	C1	0.694728	C1	0.705379	C3	0.715661
Zornitza	C3	0.703393	C3	0.693313	C1	0.719957
Izgrev	C1	0.680232	C1	0.706163	C3	0.715442
Lazur	C3	0.704157	C3	0.698172	C1	0.692983
Meden Rudnik A	C2	0.614961	C2	0.711689	C2	0.714913
Meden Rudnik B	C2	0.709219	C2	0.716807	C2	0.718825
Meden Rudnik V	C2	0.697687	C2	0.698708	C2	0.715112
Meden Rudnik G	C2	0.700844	C2	0.718475	C2	0.721766
Meden Rudnik D	C4	0.704987	C2	0.696739	C2	0.712453
Sarafovo	C4	0.695416	C1	0.596767	C3	0.672866
Slavejkovo	C1	0.645164	C1	0.712165	C3	0.711576
Centar	C3	0.686639	C3	0.677407	C1	0.710283

TABLE XII
ALL APARTMENTS CLUSTERING

Year	2019	2019	2020	2020	2021	2021
Neighborhood	Cluster	Silhouette	Cluster	Silhouette	Cluster	Silhouette
Bratja Miladinovi	C3	0.525067	C3	0.538797	C4	0.670006
Vazrazhdane	C3	0.69287	C1	0.696787	C3	0.68824
Zornitza	C1	0.715781	C3	0.706892	C1	0.737365
Izgrev	C3	0.700227	C1	0.715274	C3	0.719701
Lazur	C1	0.687205	C3	0.700483	C4	0.595442
Meden Rudnik A	C2	0.705714	C2	0.714741	C2	0.724136
Meden Rudnik B	C2	0.71183	C2	0.718238	C2	0.723632
Meden Rudnik V	C2	0.698586	C2	0.700588	C2	0.717627
Meden Rudnik G	C2	0.710806	C2	0.716567	C2	0.720662
Meden Rudnik D	C2	0.625419	C2	0.673774	C2	0.705452
Sarafovo	C3	0.598462	C1	0.622882	C3	0.692775
Slavejkovo	C3	0.704975	C1	0.71283	C3	0.718658
Centar	C1	0.704715	C3	0.695956	C1	0.736276

4. Discussion

The price change per square meter for most of the 1-bedroom apartments by neighborhood follow almost one and the same trend (Fig.1). The situation on the market seems stable. The same is true for the 2- and 3-bedroom apartments (Fig. 2 and 3). For the latter there is small increase of the prices over months. The cumulative distribution for all apartments in 2019 is segmented in 3 modes - low prices between 500 and 700 EUR/m², to middle mode of around 900 EUR/m² and a high one - above 900 up to 1100 EUR/m² (Fig. 5). In 2020 the segmentation remains 3-fold as well. Here the low-price market seems to have shrunk in the range of 500 to 600 EUR/m² with increase of the number of real estates in the middle zone - from 700 to 900 EUR/m² and tight upper price area of around 1000 EUR/m² (Fig. 6). In contrast to that, the tendency in 2021 is to almost completely equalize the market in relative number of apartments by price as Fig. 7 shows.

The most increase of the living area for the whole 3 year period happens for the Zornitza neighborhood ($m=8.64$, Table VI), followed by Bratia Miladinovi ($m=8.51$) and Sarafovo ($m=7.50$). At the bottom of the list are Centar ($m=1.50$), Meden Rudnik A ($m=1.37$) and Meden Rudnik D ($m=-3.13$).

The segmentation of the market in groups by price tag, obviously, varies among the years. Only 2 clusters exist for 1-bedroom apartments in 2019, followed by 4 clusters in 2020 and 2021 (Table VIII). From 4 clusters in 2019 the 2-bedroom apartments form 3 clusters in 2020 and 2021. The same is distribution with the 3-bedroom apartments. These results are important in terms of the marketing strategy the house broker companies undertake in their offerings and the way they organize their catalogs of available real estates. The most expensive neighborhoods for 2019 are Zornitza, Lazur and Centar (Fig.8, Table XII), while in 2020 these are Bratia Miladinovi, Zornitza, Lazur and Centar (Fig. 9, Table XII). In 2021 the top offered apartments by price are located in Zornitza and Centar (Fig. 10, table XII). The global discrimination in number of clusters for all apartments varies from 3 in 2019 and 2020 to 4 in 2021 - another indicator as to how the broker agencies could reorganize their offerings and seek for the proper clients.

5. Conclusions

In this paper an analysis is presented on the price variation and distribution for the real estates in the city of Burgas, Bulgaria, for the period 2019-2021. With the exception of Meden Rudnik D, there is an increase in price per m² for all types of apartments in the neighborhoods with a pace from 1.37 up to 8.64 from the linear approximation of the trends. There is distinct fragmentation to low-, mid- and high-priced real estates in 2019 and 2020 but with the appearance of the pandemic from COVID-19, the share of the mid-priced apartments increased. In 2021 there is a process of equalization of the market share of the various priced households. As the general tendency reveal, the two sequential strict lockdowns in 2020 and other factors contributed to the demand for mid-priced apartments more than every other type. In 2021 the number of types by price rose from 3 in 2019 and 2020 to 4. Further analysis is needed for the continuous distribution of the actual demand for any of these 4 types of real estates.

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Contribution of individual authors to the creation of a scientific article (ghostwriting policy)

Marin Marinov gathered the raw data, pre-processed it and then aggregate the records in a database. Ivo Draganov made the statistical analysis over the aggregated data and then made conclusions.

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