

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

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Abstract: In this paper in-depth analysis of the price variation of the 1-, 2- and 3-room real estates in the city of Shumen, Bulgaria for the period 2019-2021 is presented. Apart from the price timeseries, histograms and their continuous approximating distributions are given along with clustering of the neighborhoods of the city by price class. K-Means algorithm is used with associated Silhouette scores which reveal the number of the classes in each of the studied years. Not only the effect of the emerging COVID-19 pandemic could be observed from the obtained results but they could be useful guide for brokerage house managers into establishing appropriate marketing strategies while offering various price tag residences.

Keywords: residence, price variation, Shumen, Bulgaria, pandemic, COVID-19.

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1. Introduction

SHUMEN is one of the municipalities in Bulgaria. It is significant economic center [1] and as a such its geographical location could be determined as strategic. Nearby populated places make the town major budget spending unit [1] which influence the real estate market in it as well. Some of the factors that strengthen the housing demand are the presence of 3 international roads passing through the territory of the municipality.

The COVID-19 pandemic put new challenges in front of the free trade in Bulgaria. Two subsequent strict lockdowns and many additional restrictions made most of the potential real estate buyers to increase their savings. The period from 2019 to 2021 is particularly interesting in terms of the tendencies in the trade of living areas. Predisposition to the current situation in the real estate market should be looked in the housing policy. In [2] Ignatova investigates the strategic goals, operational directions and indicators of the housing policy in the region within the period from 2010 to 2014. The housing affordability dropped steadily from 9.4 to 6.5 during this time. As a main reason it is pointed out the decrease of the price per square meter living area of 12% and increase of the average annual salary with 28%. Around 17% less is the difference with the price of the housings than the neighboring municipalities. In the same time the number of dwelling houses drop from 56 676 to 53 279, and the residences – from 91 457 to 88 818. The demand for 3-room apartments rose from 30.5% to 31.8%.

Additional factors, influencing the market in the area, are the growth of the tax rate on the retail trade of 51% [3] and the pace of enrichment of the local business, which is low for the period 2012-2016 with a mark varying between 1.14 and 1.27 [4].

Given 72997 inhabitants of Shumen, the total number of newly built residential buildings in 2015 is 26, and 50 – in 2020 [5]. The number of real estate sales in 2015 are 3290 and in 2020 – 2318 [5]. As Atanasova [5] concludes, 1-bedroom apartments have the most increase in number due to the more affordable total price, while the migration, the higher demand, the absence of preserved financial actives, and the extremely low profitability of bank savings lead to the rise of housing prices, more in smaller cities than in major ones.

In [6] a model for the estimation of the price of various real estates is presented for the particular case of Bulgaria and directions for its implementation as SaaS are given. In its base is a spatial regression model related to hedonic pricing. It takes as variables the average monthly salary, the ratio among the engaged in the district population and the population itself. This model could be employed with some of the results from the current study.

Another model [7], which could be used with the results from this study, is implemented in an Early Warning System for the real estates in Bulgaria. The authors take as input housing price index, sectoral crisis indicators in order to get unified EWS index. Warning alarms are raised six months prior the crisis. The risks involved in the real estate investments could be derived from a fuzzy logic model [8] as developed by Zlateva et al. It is a hierarchical system incorporating 3 political, 2 social, 4 economical and 2 contractual risks.

Irregularities in the real estate market, such as unreal by price residential listings, could be detected by finding the number of days that the listing stays available to the customers [9]. This is the base for a predictive model which could use some of the popular machine learning algorithms, e.g. Lasso regression, Ridge regression, Elastic Net and Artificial Neural Network as used by Castelli et al. From them the Lasso regression is thought to be the most appropriate.

Another approach [10] into the prediction of the prices of real estates in Bulgaria, defined through the House Price Index, finds that the interest rates and internal inertia of the market are the main driving factors among others, such as the market demand, the business cycle of the construction industry and the overall macroeconomic state. Hybrid autoregressive model turns out to be appropriate for the case.

The main goal of the current study is to analyze the variation of the prices of the real estates in the city of Shumen, Bulgaria in the period 2019-2021. Histograms and approximated distributions of the prices are found along with groupings of the neighborhoods of the city by a price category using the K-Means clustering. In section II of the paper the initial processing of the data is described, followed by experimental results in Section III, discussion in Section IV and conclusion in Section V.

2. Preprocessing of Input Data

The preprocessing process is described below:

1. Data separation:
 - a. The raw data is separated manually and then saved as Excel files. The data represents the real estate price per month starting from January 2019 till December 2021.
 2. Data filtration – automated C# tool is compiled for removing empty columns and rows of no significance from all the Excel files.
 3. Data conversion
 - a. Arranged data within the filtrated Excel tables is then loaded into designated multi-stage MS SQL Server database.
 - b. Conversion to time sequence per month - the data out of the multi-stage tables is then inserted into new per month sequences.
 - c. Arrangement of the data in quarters within the year - View database objects allow internal transformation in quarters from the monthly time tables.
 4. Datamart filling with data

The implementation of the Datamart is in the form of Excel table in which the final data is saved and it could be analyzed from that point on.

3. Experimental Results

The average prices per square meter and a neighborhood in Shumen, Bulgaria on a monthly basis are gathered from [11], a publicly available source. The change of the price on three-month periods (quarters) from 2019 to 2021 are given in Fig. 1-4. This time interval starts with a year prior the pandemic of COVID-19 – 2019, and then goes through 2020, in which the first detected case of the disease in Bulgaria was on 8th of March. There were 2 periods of significant restrictive measures against the access to public facilities in the country in that year – from 13th of March to 13th of May 2020 and

from 21st of October to February 2021. The overall period of the study includes also the whole 2021.

The average value – Av., the median – Med., and the standard deviation – St. Dev. of the price for all kinds of sold real-properties in all 9 districts of Shumen are listed in Table I. The histograms of the price distribution for 2019, 2020 and 2021 are shown on Fig. 5, 6 and 7 in green, respectively. All discrete distributions are approximated with continuous distributions, shown in red. The approximations are found using the XLSTAT application [12].

Given a significance level of 5% [13] the most proper distribution is selected from a list of preliminary known distributions by the maximum p -score generated. The results from this testing using the maximum likelihood approach are given in Table II. The value of the convergence parameter is set to 0.00001.

The descriptive values of the Weibull (2) distribution for 2019 (Fig. 5) are: $\beta = 17.619 \pm 1.186$, and $\gamma = 631.426 \pm 0.201$. The Logistic distribution (Fig. 6) is described by the values: $\mu = 602.227 \pm 0.839$ and $s = 34.258 \pm 1.186$. The Weibull (2) distribution for 2021 (Fig. 7) is described by $\beta = 12.240$ and $\gamma = 667.636$. The Log-likelihood (LL) statistics, the Bayesian Information Criterion (BIC) and the Akaike Information Criterion (AIC) of the so derived distributions are presented in Table III.

Comparison of the mean, variance, skewness and kurtosis parameters from the real data and from the predicted one by the approximations is shown in Table IV. The Pearson criterion is in the base of estimating the skewness and kurtosis.

Another test that is implemented during the analysis of the price distributions is that of Kolmogorov-Smirnov. The results from it are shown in Table V. They are used as additional confirmation of the suggested hypotheses for the 3 distributions from Fig. 5-7.

A step forward in the analysis is finding linear approximations for the trends from Fig. 4 using the linear regression model, which leads to equations of the following kind:

$$y = mx + c, \quad (1)$$

where y is the approximated price, m – proportionality coefficient, c – a free component. The resulting m and c with the adjacent accuracies Δm and Δc are listed in Table VI. They are derived by the use of MyCurveFit [14] application.

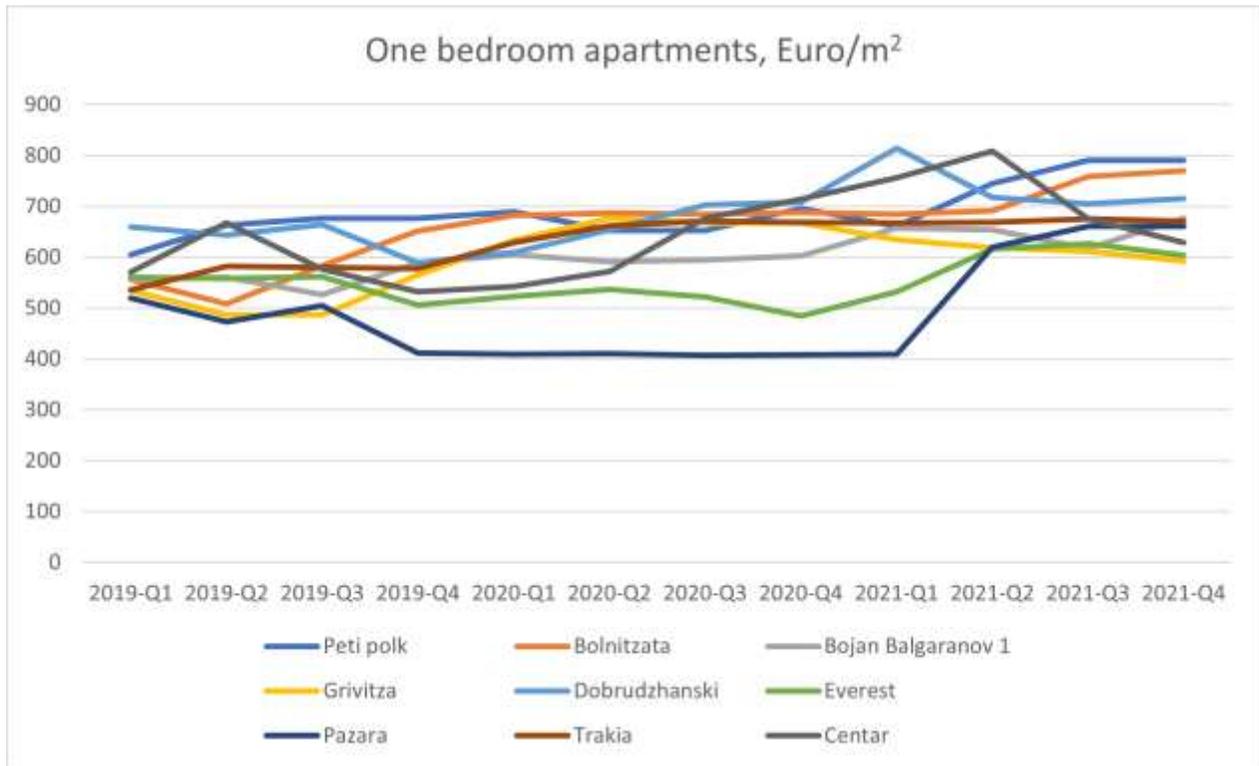


Fig. 1 One bedroom apartments price change from 2019 to 2021

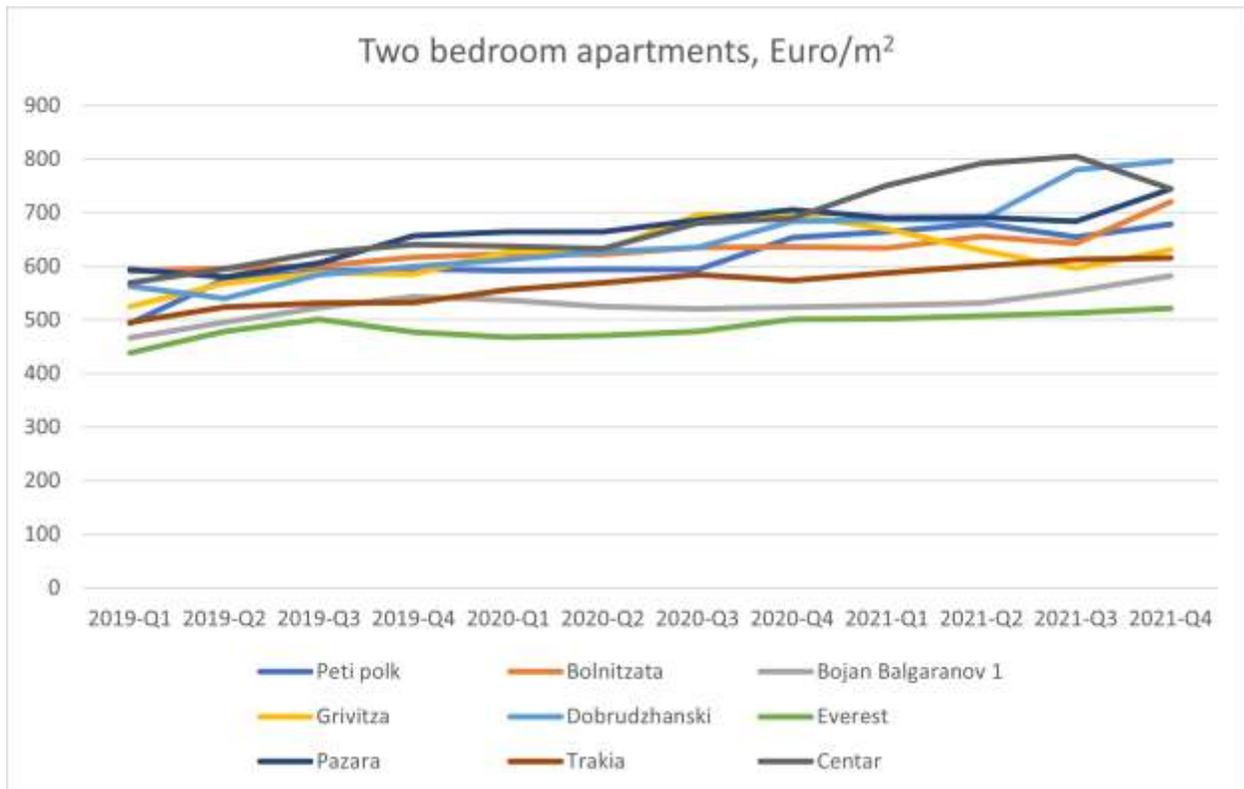


Fig. 2 Two bedroom apartments price change from 2019 to 2021

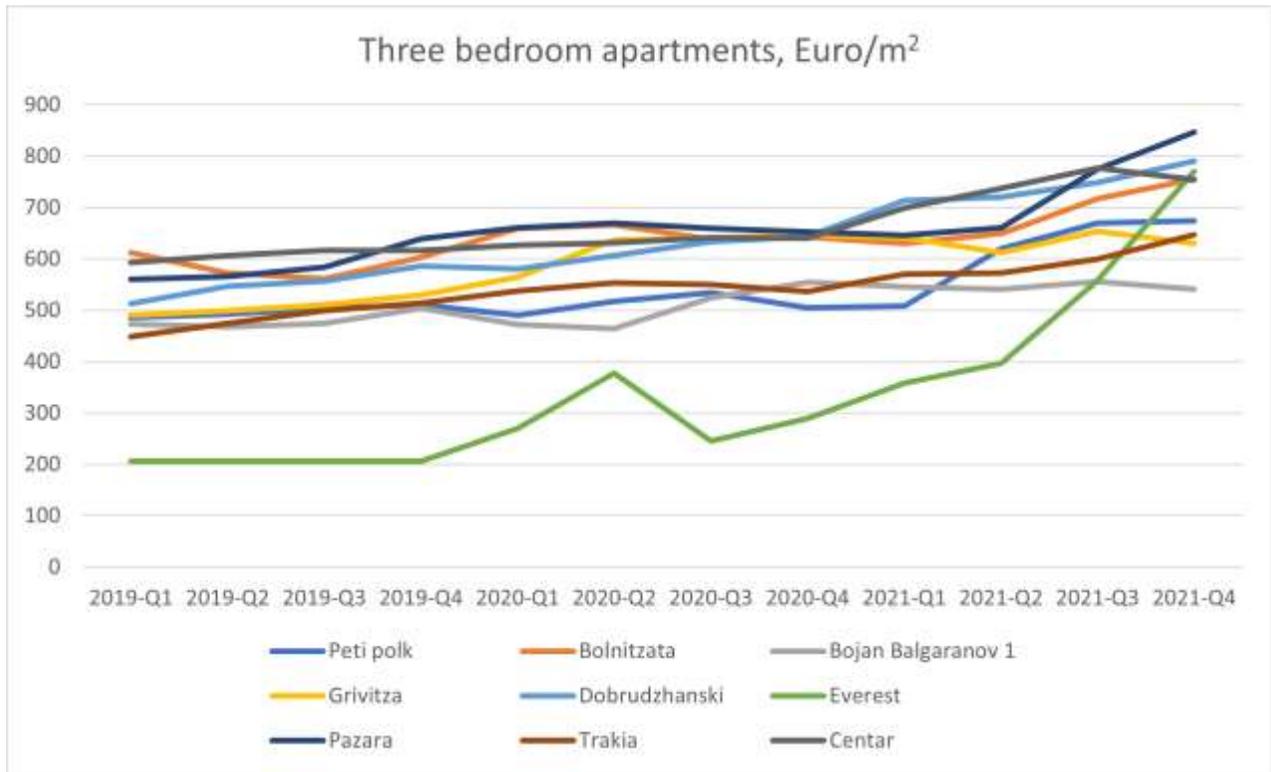


Fig. 3 Three bedroom apartments price change from 2019 to 2021

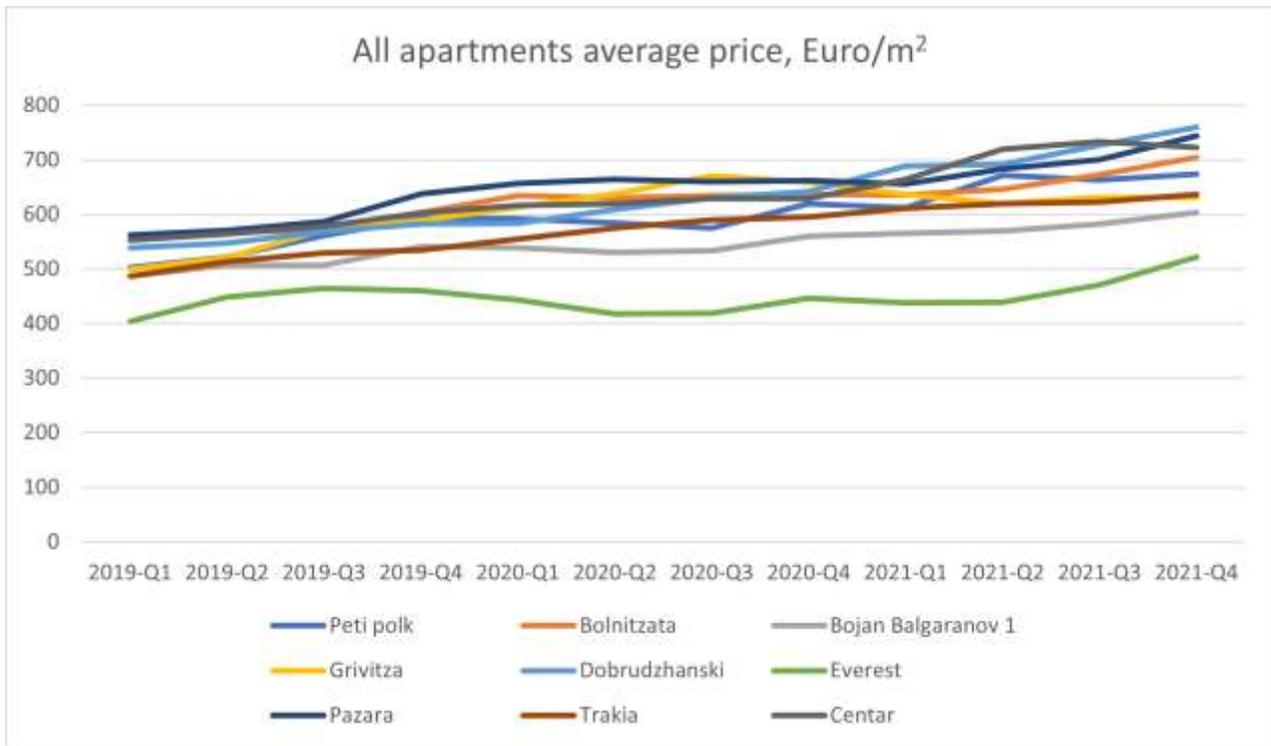


Fig. 4 All apartments price change from 2019 to 2021

The precision of the linear regressions by neighborhood is evaluated 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). All their values are shown in Table VII.

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.
Peti polk	619	541,5	182,27	592,75	588	19,45	655,25	667,5	29,23
Bolnizata	650	569,5	171,51	633,5	634	2,52	664,75	659,5	31,22
Bojan Balgaranov 1	578,25	507	156,12	540,5	536	13,53	580,25	576	17,37
Grivitza	619	546,5	178,58	645	648,5	25,13	629,5	631	7,55
Dobrudzhanski	632	558	161,17	616	619,5	25,88	716,75	709,5	33,73
Everest	501,5	456	128,2	431,5	431	15,07	467,5	455	39,43
Pazara	669,25	579	192,11	660,75	661	2,99	695,75	691,5	36,92
Trakia	582,5	521	146,69	578,75	582,5	17,97	622,25	621	10,44
Centar	649,75	571	169,81	623,25	624	6,75	709,75	721	31,06

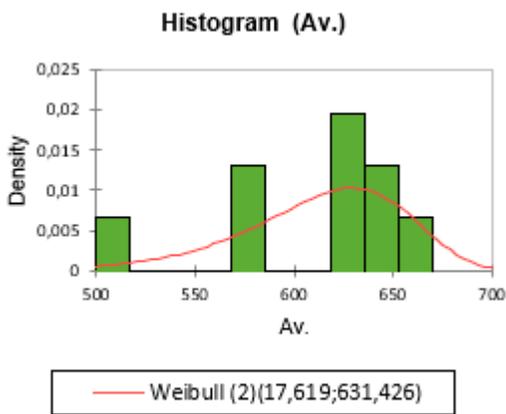


Fig. 5. All apartments price distribution for 2019

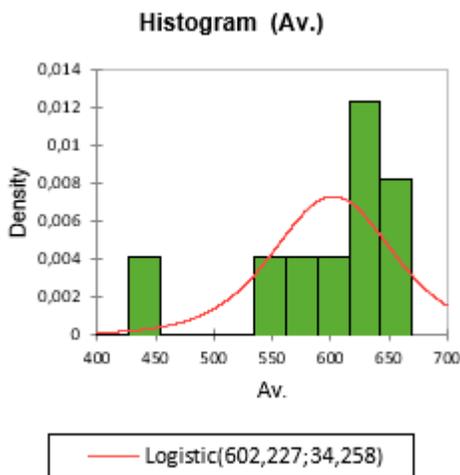


Fig. 6. All apartments price distribution for 2020

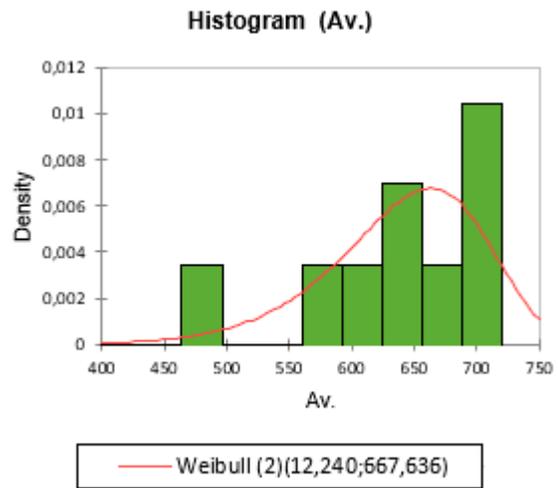


Fig. 7. All apartments price distribution for 2021

For each of the studied years clustering of the neighborhoods in classes by price is performed. The algorithm used is K-Means, where the initialization is K-means++. It is followed by 10 iterations and 300 steps as an upper limit. The applicable range of clusters is set from 2 to 8 and then the optimal number is discovered. The clustering is made with the Orange v. 3.28 software [15]. Silhouette score is used as a criterion by its maximum to establish the necessary number of classes (Table VIII).

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

Distribution	2019	2020	2021
Chi-square	-	0,175	0,372
Beta4	0,633	-	-
Erlang	0,560	0,688	0,675
Exponential	0,003	0,009	0,009
Fisher-Tippett (1)	<0,0001	<0,0001	<0,0001
Fisher-Tippett (2)	0,557	0,521	0,553
Gamma (1)	<0,0001	<0,0001	<0,0001
Gamma (2)	0,609	0,690	0,734
GEV	0,070	0,022	0,059
Gumbel	<0,0001	<0,0001	<0,0001
Log-normal	0,582	0,643	0,690
Logistic	0,877	0,960	0,973
Normal	-	0,787	0,831
Student	<0,0001	<0,0001	<0,0001
Weibull (2)	0,913	0,894	0,981

TABLE III
 LOG-LIKELIHOOD STATISTICS

Parameter	Weibull (2)	Logistic	Weibull (2)
LL	-46,569	-50,104	-50,336
BIC	97,532	104,603	105,067
AIC	97,138	104,208	104,673

TABLE IV
 ACTUAL AND PREDICTED DATA STATISTICS

Distribution	Weibull (2)		Logistic		Weibull (2)	
	Data	Predicted	Data	Predicted	Data	Predicted
Mean	611,250	612,653	591,333	602,227	637,972	640,256
Variance	2607,391	1842,020	4924,375	3861,075	6052,929	4044,286
Skewness	-0,886	-0,835	-1,159	0,000	-0,961	-0,718
Kurtosis	-0,337	1,153	0,186	1,200	-0,172	0,788

For 2019 there are 4 established price classes over the 9 neighborhoods – C2 representing the lowest price and C3 – the highest (Fig. 8). In 2020 only 2 classes emerge (Fig. 10) and in

2021 – there are 5 of them with a concentration of neighborhoods in the higher price area (Fig. 10).

TABLE V
 KOLMOGOROV-SMIRNOV TEST PARAMETERS

Distribution	Weibull (2)	Logistic	Weibull (2)
D	0,172	0,155	0,143
p-value	0,913	0,960	0,981
Alpha	0,050	0,050	0,050

TABLE VI
 LINEAR REGRESSION PARAMETERS BY NEIGHBORHOOD

District	m	Δm	c	Δc
Peti polk	14,32	1,62	504,46	11,94
Bolnitzata	11,53	1,23	549,16	9,07
Bojan Balgaranov 1	9,05	0,85	484,90	6,26
Grivitza	11,08	2,97	534,62	21,92
Dobrudzhanski	19,72	1,15	502,48	8,46
Everest	4,30	2,31	419,71	17,02
Pazara	13,76	1,66	559,21	12,22
Trakia	13,21	0,65	486,36	4,80
Centar	16,54	1,40	528,28	10,33

TABLE VII
 ACCURACY OF THE LINEAR REGRESSION MODELS

District	R ²	aR ²	P	SE	F
Peti polk	0,8862	0,8748	4,92E-6	19,40	77,92
Bolnitzata	0,8975	0,8873	2,90E-6	14,74	87,60
Bojan Balgaranov 1	0,9187	0,9106	9,00E-7	10,17	113,12
Grivitza	0,5805	0,5386	3,97E-3	35,62	13,84
Dobrudzhanski	0,9671	0,9638	9,56E-9	13,74	294,32
Everest	0,2570	0,1827	0,0925	27,65	3,45
Pazara	0,8729	0,8602	8,62E-6	19,85	68,69
Trakia	0,9761	0,9737	1,91E-9	7,80	409,45
Centar	0,9328	0,9261	3,45E-7	16,78	138,95

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	0,572	0,709	0,665	0,669	0,625	0,488	0,723	0,648	0,65
3	0,548	0,503	0,713	0,729	0,479	0,52	0,658	0,693	0,685
4	0,547	0,531	0,619	0,722	0,411	0,515	0,545	0,584	0,637
5	0,403	0,378	0,529	0,583	0,353	0,449	0,482	0,518	0,5
6	0,362	0,198	0,407	0,419	0,32	0,319	0,424	0,427	0,369
7	0,281	0,297	0,254	0,317	0,301	0,264	0,309	0,308	0,284
8	0,173	0,148	0,157	0,183	0,192	0,183	0,165	0,133	0,19

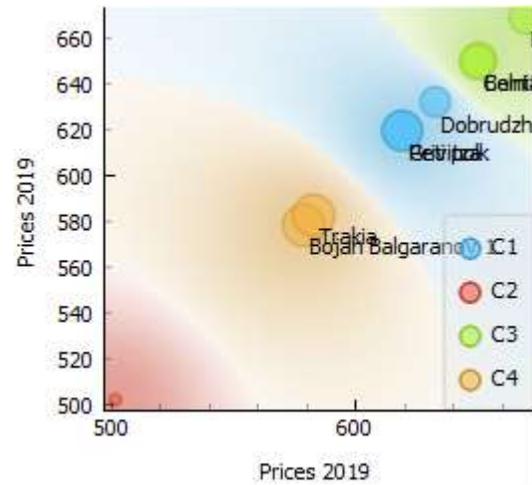


Fig. 8. All apartments clusters for 2019

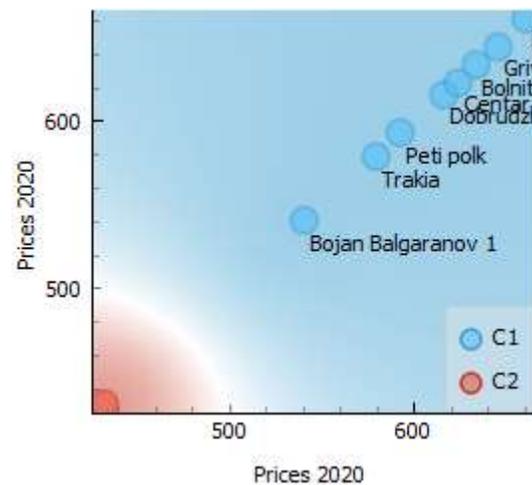


Fig. 9. All apartments clusters for 2020

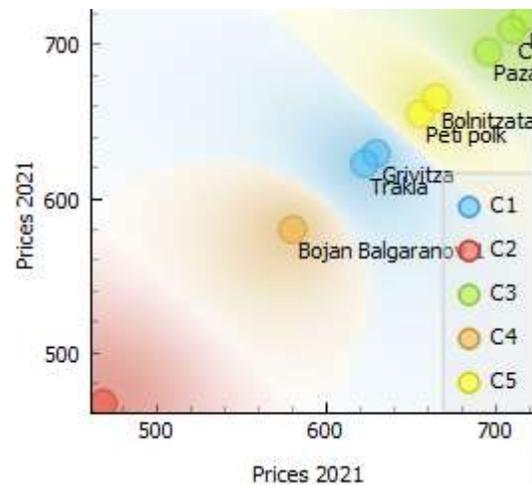


Fig. 10. All apartments clusters for 2021

Separate distributions for 1-, 2-, 3-, and all bed real estates in different number of clusters with the resulting Silhouette scores in the whole studied interval 2019-2021 per neighbourhood basis are given in Tables IX-XII.

TABLE IX

ONE BEDROOM APARTMENTS CLUSTERING

Year	2019	2019	2020	2020	2021	2021
Neighborhood	Cluster	Silhouette	Cluster	Silhouette	Cluster	Silhouette
Peti polk	C1	0.71077	C1	0.727763	C2	0.709514
Bolnitzata	C2	0.601399	C1	0.720333	C2	0.712604
Bojan Balgaranov 1	C2	0.674609	C1	0.656125	C3	0.679443
Grivitza	C2	0.678307	C1	0.729444	C1	0.646552
Dobrudzhanski	C1	0.69805	C1	0.729139	C2	0.718948
Everest	C2	0.683746	C2	0.565203	C1	0.714484
Pazara	C2	0.644778	C2	0.661999	C1	0.709056
Trakia	C2	0.659953	C1	0.728647	C3	0.691535
Centar	C2	0.618685	C1	0.705351	C2	0.684052

TABLE X

TWO BEDROOM APARTMENTS CLUSTERING

Year	2019	2019	2020	2020	2021	2021
Neighborhood	Cluster	Silhouette	Cluster	Silhouette	Cluster	Silhouette
Peti polk	C1	0.734068	C1	0.633665	C1	0.639875
Bolnitzata	C3	0.693818	C1	0.698133	C1	0.663235
Bojan Balgaranov 1	C2	0.670609	C2	0.676582	C3	0.671896
Grivitza	C1	0.735986	C1	0.716776	C1	0.690741
Dobrudzhanski	C1	0.718476	C1	0.711208	C2	0.678444
Everest	C2	0.661945	C2	0.668687	C3	0.697374
Pazara	C3	0.71957	C1	0.703021	C2	0.535077
Trakia	C2	0.6182	C2	0.534782	C1	0.597245
Centar	C3	0.725204	C1	0.717527	C2	0.670406

TABLE XI

THREE BEDROOM APARTMENTS CLUSTERING

Year	2019	2019	2020	2020	2021	2021
Neighborhood	Cluster	Silhouette	Cluster	Silhouette	Cluster	Silhouette
Peti polk	C1	0.717081	C3	0.722173	C1	0.711423
Bolnitzata	C1	0.722088	C1	0.720079	C2	0.586514
Bojan Balgaranov 1	C1	0.707098	C3	0.71846	C3	0.681729
Grivitza	C1	0.720178	C1	0.712601	C1	0.69694
Dobrudzhanski	C1	0.724306	C1	0.70052	C2	0.718821
Everest	C2	0.5	C2	0.5	C3	0.702069
Pazara	C1	0.721163	C1	0.712594	C2	0.717223
Trakia	C1	0.710895	C3	0.673365	C1	0.66094
Centar	C1	0.715874	C1	0.722206	C2	0.719929

TABLE XII

ALL APARTMENTS CLUSTERING

Year	2019	2019	2020	2020	2021	2021
Neighborhood	Cluster	Silhouette	Cluster	Silhouette	Cluster	Silhouette
Peti polk	C1	0.719739	C1	0.705047	C5	0.689345
Bolnitzata	C3	0.679945	C1	0.718556	C5	0.705976
Bojan Balgaranov 1	C4	0.734267	C1	0.580233	C4	0.5
Grivitza	C1	0.719739	C1	0.714504	C1	0.707323
Dobrudzhanski	C1	0.638744	C1	0.718321	C3	0.705505
Everest	C2	0.5	C2	0.5	C2	0.5
Pazara	C3	0.666831	C1	0.705554	C3	0.650244
Trakia	C4	0.732543	C1	0.68857	C1	0.716313
Centar	C3	0.678078	C1	0.719626	C3	0.712619

4. Discussion

The trends for 1-, 2-, 3- and all-bedroom apartments are monotonically rising for the period 2019-2021 year (Fig.1-4). The minimal registered price for 1-bedroom apartment is 400 Euro/m² for the Pazara neighborhood and the maximal - just above 800 Euro/m² for the Dobrudzhanski neighborhood (Fig. 1). Everest is the cheapest by absolute value in the 2-bedroom apartments neighborhood with around 450 Euro/m², while the Centar is the most expensive with around 800 Euro/m² for that type of real estates (Fig. 2). Everest is also the cheapest with 200 Euro/m² in the 3-bedroom apartments sector and Pazara is most expensive here with 850 Euro/m² (Fig. 3). For all bedroom apartments all neighborhoods are very close in price variation from around 500 Euro/m² to around 750 Euro/m² with the exception of Everest where the prices deviate from 400 Euro/m² to 500 Euro/m² (Fig. 4). The price for the first 8 neighborhoods is steadily rising within the whole period.

With regard to the emergence of the COVID-19 pandemic at the end of 2020-Q1, there is no firm indication for a significant change of the prices for any type of apartment. The only noticeable increase from around 250 Euro/m² in 2020-Q1 to around 380 Euro/m² in 2020-Q2 is for the 3-bedroom apartments in the Everest neighborhood (Fig. 3).

There are 3 distinctive groupings of the apartment prices for 2019 as the histogram from Fig. 5 reveals - around 500, 575 and 650 Euro/m². Majority of the offered apartments fall within the highest price group. In 2020 there are only 2 modes of the histogram - around 450 and 600 Euro/m², again with dominance in the number of apartments with the higher mode (Fig. 6). The price distribution for 2021 is somewhat similar with a little increase of the lower mode to 475 Euro/m² (Fig. 7).

The linear regression approximations indicate the most significant rise of the real estate's price for the Dobrudzhanski neighborhood with $m = 19.72$ (Table VI). The least is the increase for the Everest neighborhood with $m = 4.30$. All the rest neighborhoods are in-between, having also firm rise of the prices. With the exception of Everest ($R^2 = 0.2570$) and Grivitza ($R^2 = 0.5805$) the accuracy of the linear approximations for the rest of the neighborhoods is above 0.87 which could be determined as satisfactory.

The clustering of the neighborhoods for all apartments in 2019 leads to 4 price groups - Everest as the only representative in the cheapest one, Bojan Balgaranov 1 and Trakia as more expensive, Peti polk, Grivitza and Dobrudzhanski with even higher average price and Bolnitzata, Pazara and Centar as the most expensive (Fig. 8). The segmentation picture by price drastically changes in 2020 with only 2 clusters - Everest again as the only and cheapest neighborhood, and all the rest in the cluster of the most expensive neighborhoods (Fig. 9). There is no strong indicator that the COVID-19 pandemic is the main cause for this change. Moreover, with the ongoing price rise in 2021 there is a remarkable splitting of the market to 5 clusters (Fig. 10). Everest still is the only and cheapest neighborhood, followed by Bojan Balgaranov 1 in a separate group, Grivitza and Trakia in more expensive one, then follow Peti polk and Bolnitzata, and the last and most expensive are Dobrudzhanski, Pazara and Centar. This more discriminated pattern could be due to the dynamic political situation in the country in 2021 with 2 consecutive elections for a parliament and 1 presidential vote, while the COVID-19 pandemic seems to have even smaller effect, if any, with loosening the restrictive measures further. Evidence for the positive effects on the market is the ever-growing average prices of all types of real estates in the city during 2021.

Not so diverse is the distribution by price classes for the 1-bedroom apartments alone - in both 2019 and 2020 there are only 2 classes of separation and in 2021 - a third class appears with Bojan Balgaran 1 and Trakia neighborhoods (Table IX). For the 2-bedroom apartments 3 classes exist for 2019 and 2021 and in 2020 - there are only 2 classes (Table X). In

addition to that, 3 classes persist for 2020 and 2021, while for 2019 - there are only 2 classes for the 3-bedroom apartments with the Everest neighborhood forming one of the classes (Table XI).

The obtained results could be useful in numerous instances:

- for statistical purposes for tracing back the evolution of the real estate market before and during the COVID-19 pandemic;
- for predicting the future development of the market by its segmentation both in price and location;
- for forming attractive marketing strategies of brokerage houses by selecting certain properties under one group not only by their price but also by neighborhood;
- for adaptive offering based on add intensity and possible price variation of properties which once were hard to sell.

5. Conclusions

In this paper in-depth analysis is presented on the price variation of the real estates in Shumen, Bulgaria, for the period 2019-2021. The market of 1-, 2- and 3-bedroom apartments show monotonical increase of the average prices during the whole time, including the COVID-19 pandemic and it is more emphasized in 2021. The discrete distributions of the prices by year for all apartments are right offset with a prevail of those properties from the higher price range - around 650 Euro/m². Linear regression over the average price for all neighborhoods of Shumen confirms the rising value of the apartments with a factor from 4.30 to 19.72. Segmentation by price for the whole city taking as base units the neighborhoods is quite variable - 4 clusters exist in 2019, followed by 2 in 2020 and 5 - in 2021. There is no direct evidence that the COVID-19 pandemic affected the market to an extent observable at this abstract level. It seems that the market preserves its fluent change to higher prices.

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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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