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Analysis of Land Markets Intended for Single-Family Housing for Different Suburban Areas*

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Abstract. The aim of this article is the comparative description of two real estate markets based on the procedures for real property valuation. The study concerned only the land, which was undeveloped, intended for single-family housing in two communes located in the district of Krakow and three communes from the district of Kielce. The analyses were performed at four-year intervals and the comparison of the real estate markets was conducted.

The first part contains the description of the areas covered by the research studies and the analyses of the real estate market and market trends. The next stage includes the descriptions of the two test real properties which are the subject of valuation and the fundamental comparative criterion. Then, the algorithms and methods of the calculations are presented. The practical part contains the description of individual markets, the implementation of the analyses and calculations, the comparison of the study areas and conclusions.

The comparative analysis of the performed simulations of valuations was carried out first and then followed by a collective summary of descriptive statistics of all the real estate bases and the comparative description of the structures of the databases showing meaningful differences between Krakow and Kielce region.

Keywords: land markets, real property valuation, undeveloped land.

Conference topic: Technologies of Geodesy and Cadastre.

Introduction

The aim of this article is to make a comparative analysis of two real estate markets based on the real property valuation. Six simulations were performed in which, for individual study areas, the real property valuation was carried out at three points in time, at four-year intervals: as of 1 January 2006, 1 January 2010, and 1 January 2014.

The study covered two different districts: the district of Kielce and the district of Krakow (Stefański 2014). The main objective was to compare the land market intended for single-family housing, in close proximity to two extremely different provincial cities (Buśko, Meusz 2014). In order to analyze the so-called "urban bedrooms", the selected communes of the neighboring provincial cities were taken into consideration (Przewięźlikowska, Buśko 2014). The selection was based on the well-known opinions as to the attractiveness and popularity of the location of new estates of single-family houses (Mika, Leń 2016).

The analyzed properties in specific areas were selected in such a way so that it was possible to compare them. Their attributes were as follows: in both cases these were undeveloped plots of land, with an area of slightly less than 1000 m² which, in accordance with the local zoning plan, were intended for the construction of homestead buildings or single-family housing. When selecting the study objects, special attention was paid to the significant price-determining attributes, such as the shape of the plot, location, environment, communication and fashion.

The transactions details were obtained electronically from the records of prices and real estate values for the communes. From these records, basic attributes were obtained (transaction date, repertory number of the notarial deed, plot number, cadastral district, surface area, price, type of property and zoning details). Only these transactions were selected which involved undeveloped land, intended for single-family housing, or for buildings other than homestead buildings, subject to free market trading. Both the purchasing party and the selling party had to be natural persons.

Other price-determining attributes such as: the shape of the plot, location, environment, communication and fashion were captured basing on the data from the web portal Geoportal (https://geoportal.powiat.kielce.pl/) and the web service (http://sip.ztm.kielce.com/). The data on the technical infrastructure and public utilities were not captured. The scale and descriptions of the price-determining attributes are demonstrated further in this article, with the presentation of the databases and the results.

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Description of the test properties

In order to estimate the value of the real property in the specific area, the test property was selected. The valued object was not changed in the subsequent time intervals, so that it was possible to compare the subsequent analyses which were performed. It was also assumed that the attribute values for a given real property did not change in the following intervals. Under these assumptions, the same object was valued basing on different databases, thus examining the influence of the similar real properties on the value of a theoretical object.

In order to compare the results of the research, not only in the context of a specific market at different time stages, but also to compare the results of one market to another, the theoretical test properties on both markets have identical values of the price-determining attributes (shape, location relative to the local center and to the provincial city, environment, communication, fashion) as well as comparable surface areas.

Results of the performed studies

The valuation process, used in the practical part of this study, was modified compared to the classical method of pairwise comparisons (Czaja, Parzych 2007). The modified procedure of pairwise comparisons was used [KSWP 1, 2010], whose primary objective is to refer the real property being valued to the theoretical property of the average values of all the attributes in the database (Jasińska 2012). A diagram of the subsequent calculations (not taking into account the stage of price adjustment due to the passage of time and the calculation of the weights of the attributes) is as follows (Barańska 2011):

1. Assigning numerical scales to the attributes and assigning specific values to individual real properties;
2. Calculating the average attributes of the theoretical real property based on all (n) plots from the database:

$$\hat{a}_m = \frac{\sum_{i=1}^{n} a_m}{n}, \tag{1}$$

where: $\hat{a}_m$ – the mean value of the m-th attribute; $\sum_{i=1}^{n} a_m$ – the sum of the values of the m-th attribute of all the real properties in the database; n – the number of the real properties in the database.

3. Calculating the average price of the adjusted real estate prices:

$$\hat{C} = \frac{\sum_{i=1}^{n} C_K}{n}, \tag{2}$$

where: $\hat{C}$ – the average of the prices after the adjustment from the whole database; $\sum_{i=1}^{n} C_K$ – the sum of the adjusted prices of all the real properties in the database; n – the number of the real properties in the database.

4. Comparison of the calculated earlier (at the stage of the analysis) correlation coefficients of the m-th attribute with the price (r_m) and the weights of the attributes (K_m), where: m – the number of the attributes significantly affecting the price;

5. Selecting the minimum values $(a_{m\,min})$, (C_{min}) and the maximum values $(a_{m\,max})$, (C_{max}) within the m-th attribute;

6. Calculating the differences in values within the m-attributes between the real property being valued and the theoretical property of average attributes:

$$\Delta_m = a_{w/m} - \hat{a}_m. \tag{3}$$

7. Calculating the quota share per attribute unit in shaping the price (taking into account the significance of the attribute):

$$\Delta C_m = \frac{C_{max} - C_{min}}{a_{m\,max} - a_{m\,min}} \cdot K_m. \tag{4}$$

8. Calculating the unit value of the real property:

$$w = \hat{C} + \sum_{i=1}^{m} \left[\Delta C_m \cdot \Delta_m \right] \left[\frac{zł}{m^2} \right]. \tag{5}$$

9. Calculating the market value of the real property (including the surface area (p)):

$$W = w \cdot p\,[\text{zł}]\,. \tag{6}$$

Table 1 presents a comparison of the analyzed databases including the study areas and relative to the time intervals which the data come from. It was prepared basing on the studies presented in (Stefański 2014).

Database KIE-1 includes sale and purchase transactions of undeveloped land, intended for single-family housing in the district of Kielce in the years 2004–2005.

The analyses preceding the valuation of the test property, the cross-correlation matrix between the attributes was established and the influence of the attributes on the price of the property was determined, as demonstrated in Tables 2 and 3. Then, the correlation coefficient of the attributes was defined {unit transaction price} – {time} $r_t = 0.6062$ – strong correlation (required adjustment of unit prices of real properties in the database KIE-1 due to the passage of time) and $r_t^2 = 0.3675$. On this basis, Figure 1 illustrates the linear regression model of the attributes {unit transaction price} – {time}.

Table 1. Summary of the analyzed real estate databases

Study area	Database name	Time interval	Valuation date
Kielce district	KIE-1	2004–2005	01.01.2006
	KIE-2	2008–2009	01.01.2010
	KIE-3	2012–2013	01.01.2014
Krakow district	KRA-1	2004–2005	01.01.2006
	KRA-2	2008–2009	01.01.2010
	KRA-3	2012–2013	01.01.2014

Table 2. Cross-correlation matrix between the real estate attributes

	Surface area	Shape	Location	Environment	Communication	Fashion
Surface area	1.00					
Shape	–0.24	1.00				
Location	0.14	0.15	1.00			
Environment	–0.10	0.05	0.30	1.00		
Communication	0.65	0.14	0.57	0.31	1.00	
Fashion	0.38	0.38	0.00	0.23	0.31	1.00

Table 3. Determining the influence of the attributes on the price of the real estate

	r_m	r_{m2}	K_m	r_{m2}	K_m	K_m [%]
Surface area	–0.1812	0.0329	0.0250	X	X	X
Shape	0.2923	0.0854	0.0651	0.0854	0.0668	7%
Location	0.5511	0.3038	0.2315	0.3038	0.2374	24%
Environment	0.5610	0.3147	0.2398	0.3147	0.2460	25%
Communication	0.5930	0.3517	0.2680	0.3517	0.2749	27%
Fashion	0.4732	0.2239	0.1706	0.2239	0.1750	18%
	TOTAL	1.3122	1.0000	1.2794	1.0000	100%

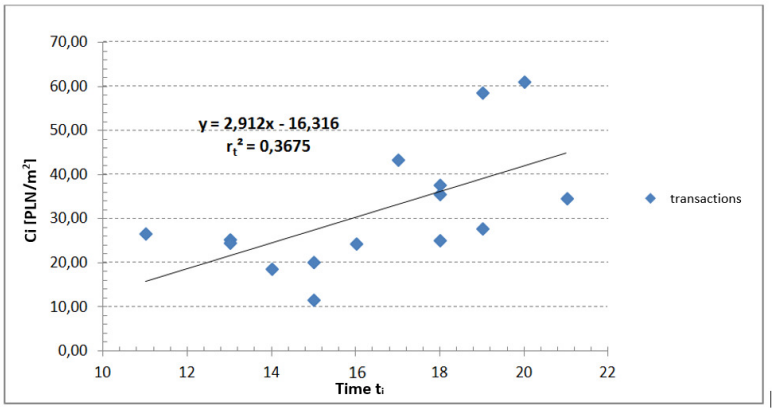

Fig. 1. Graph illustrating the influence of time on the transaction price

Basing on the above calculation results, transaction unit prices were adjusted in the database KIE-1 as of the date of the test property valuation (1 January 2006), presented in Table 4.

Table 4. Adjustment of the unit prices as of the valuation date in the database KIE-1

No.	Date	Transaction price (Ci) [PLN/m²]]	Time (ti) [months]	tw-ti [months]	Adjusted price as of 1st January 20016 CK [PLN/m²]
KIE-1-1	2004.11.15	26.67	11	13	64,52
KIE-1-2	2005.01.10	25.29	13	11	57,32
KIE-1-3	2005.01.10	24.51	13	11	56,54
KIE-1-4	2005.02.17	18.66	14	10	47,78
KIE-1-5	2005.03.14	20.06	15	9	46,27
KIE-1-6	2005.03.23	11.54	15	9	37,75
KIE-1-7	2005.04.07	24.34	16	8	47,64
KIE-1-8	2005.06.02	37.59	18	6	55,06
KIE-1-9	2005.06.05	25.13	18	6	42,60
KIE-1-10	2005.09.30	34.68	21	3	43,42
KIE-1-11	2005.06.29	35.48	18	6	52,96
KIE-1-12	2005.07.11	27.70	19	5	42,26
KIE-1-13	2005.05.25	43.33	17	7	63,72
KIE-1-14	2005.08.16	61.05	20	4	72,70
KIE-1-15	2005.07.25	58.50	19	5	73,06
KIE-1-WN	2014.01.01	–	24		

Test property valuation was carried out basing on the unit prices calculated in Table 4, adjusted as of the valuation date. The results are demonstrated in Table 5.

The unit value of the test property was estimated at the level of 56.54 PLN/m², however, taking into account the surface area of the plot, its predicted value is 53.712 PLN.

Basing on the real estate database, the following values characterizing the analyzed data set were determined:

– the average unit price of the real estate in the database KIE-1 (the prices adjusted as of the valuation date),

- the result of point estimation of the average adjusted unit price of the real estate:

$$\hat{C}_{KIE-1} = 53.57 \pm 2.86 \left[PLN / m^2 \right];$$

- the result of the interval estimation of the average adjusted unit price of the real estate:

$$\hat{C}_{KIE-1} \in \left[47.44; 59.71\right] \left[\frac{PLN}{m^2} \right]$$ assuming the probability level p = 95%;

- variance of the adjusted prices of the real estate in the database KIE-1: $\sigma^2_{KIE-1} = 114.5315 \left[\left(\frac{PLN}{m^2} \right)^2 \right]$;
- standard deviation from the sample in the database KIE-1: $\sigma_{n-1/KIE-1} = 11.0776 \left[PLN / m^2 \right]$.

Basing on the estimation of the average adjusted unit price, the data set of the real properties was divided into 3 groups: the real properties with the price within the specific range: $\hat{C}_{KIE-1} \in \left[47.44; 59.71 \right] \left[PLN / m^2 \right]$, as well as the real properties which are cheaper or more expensive.

On the basis of the price-specific division, and with regard to the attributes, the analysis of the database KIE-1 structure was performed. According to the applied division, the real properties which fell within the range of "average unit price" accounted for 40% of all objects in the database. The cheaper real properties accounted for 33.33% of the share in the database, and the more expensive ones – 26.67%.

The proposed three-part division of the database KIE-1 can be the basis for additional illustrations in the form of diagrams of the distribution of the real estate values of each attribute within specific groups. The bar charts below illustrate the analysis of the distribution of the attribute values in the group of the real properties, respectively: the cheapest and with the price close to the average price in the database (Fig. 2) and the most expensive (Fig. 3).

Basing on the above data, the overall analysis for the real properties of the database KIE-1 was performed, which is illustrated in Figure 4.

Similarly, as for the database KIE-1, valuation and analysis of all the databases in specific years in the district of Kielce and in the district of Krakow were performed. Individual results of the valuations are compared in the tabular form (Table 6).

Table 5. Test property valuation in the district of Kielce as of 1 January 2006

Database KIE-1								
No.	C_i [PLN/ m^2]	Surface area [m^2]	Shape of the plot	Location	Environ-ment	Commu-nication	Fashion	CK [PLN/m^2]
KIE-1-1	26.67	1500	3	3	3	3	2	64,52
KIE-1-2	25.29	692	3	2	3	1	2	57,32
KIE-1-3	24.51	612	3	2	2	1	3	56,54
KIE-1-4	18.66	1608	2	2	2	1	1	47,78
KIE-1-5	20.06	1027	3	2	2	2	2	46,27
KIE-1-6	11.54	1300	3	2	1	1	2	37,75
KIE-1-7	24.34	1027	3	2	2	1	2	47,64
KIE-1-8	37.59	1011	3	2	2	1	2	55,06
KIE-1-9	25.13	975	3	2	1	1	1	42,60
KIE-1-10	34.68	865	2	2	2	2	2	43,42
KIE-1-11	35.48	1550	3	2	2	3	2	52,96
KIE-1-12	27.70	1011	3	2	2	2	2	42,26
KIE-1-13	43.33	900	3	2	3	2	2	63,72
KIE-1-14	61.05	835	3	3	2	3	2	72,70
KIE-1-15	58.50	1000	3	2	2	3	3	73,06
KIE-1-WN	-	950	3	2	2	2	3	-
	$\hat{a}_m$	1060.87	2.87	2.13	2.07	1.80	2,00	53,57
	$\hat{\sigma}_m$	299.97	0.35	0.35	0.59	0.86	0,53	11,08
	r_m		0.2923	0.5511	0.5610	0.5930	0,4732	
	K_m		0.07	0.24	0.25	0.27	0,18	
	$a_{m\,min}$	612	2	2	1	1	1	37,75
	$a_{m\,max}$	1608	3	3	3	3	3	73,06
	$\hat{a}_w$	950	3	2	2	2	3	
	Δ_m	–110.87	0.13	–0.13	–0.07	0.20	1,00	
	MPP	0.00	2.36	8.38	4.34	4.85	3,09	56,54
						W = 53 712.10 PLN		

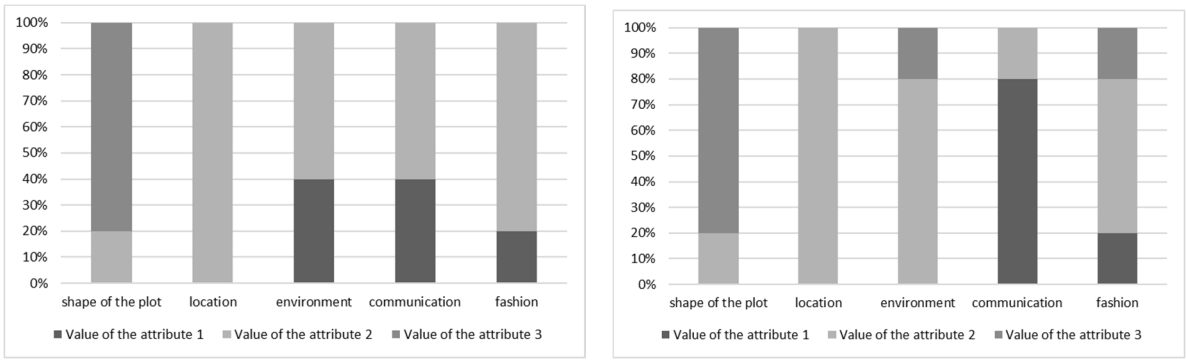

Fig. 2. Distribution of the attribute values in the group of the real properties: the cheapest and the average price in the database KIE-1

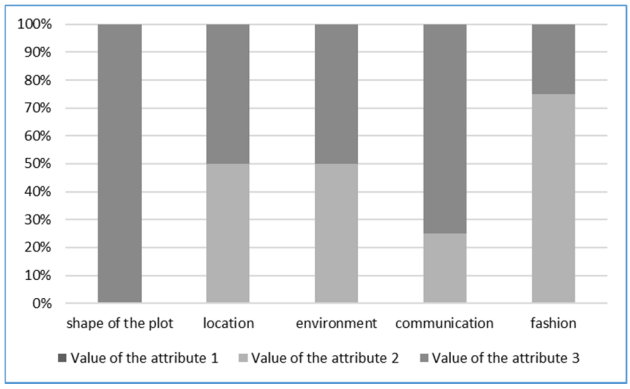

Fig. 3. Distribution of the attribute values in the group of the most expensive real properties in the database KIE-1

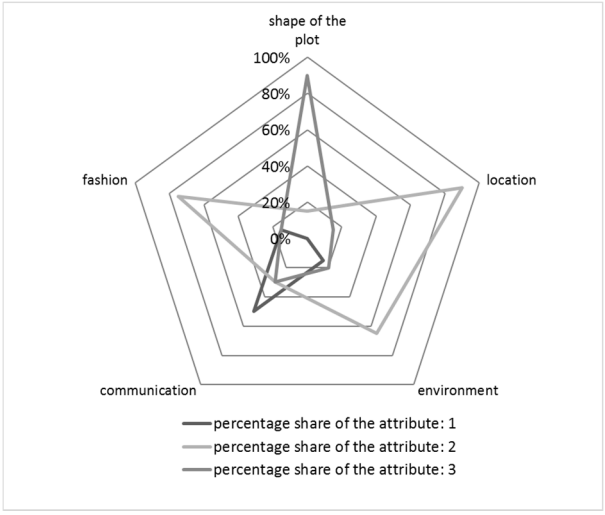

Fig. 4. Radar distribution of the attribute influence on property values in the database KIE-1

Comparison of the test results

Summarizing the performed analyses, the obtained results were compared in the tabular form, and on this basis, the Kielce and Krakow real estate markets were compared in terms of land intended for single-family housing in suburban areas.

Basing on these analyses, conclusions were drawn and study areas were characterized taking into account both the similarities and the differences. Subject to the simulations carried out at different points in time, the dynamics of the development of specific areas was analyzed. Also, the conclusions were drawn from the analyses of the structures of various databases of similar real properties, which have been performed in the previous part of the study.

Table 6. Comparison of the results of the real estate valuation

Study area:	District of Kielce	District of Krakow
Test real property	Record parcel no. 441/3 surface area: 950 m^2 attributes: shape of the plot – 3 location – 2 environment – 2 communication – 2 fashion – 3	Record parcel no. 815/4 surface area: 986 m^2 attributes: shape of the plot – 3 location – 2 environment – 2 communication – 2 fashion – 3
VALUATION RESULTS	DATABASE KIE	DATABASE KRA
1 January 2006	56.54 PLN/m^2 (53 712.10 PLN)	86.87 PLN/m^2 (85 651.74 PLN)
1 January 2010	75.95 PLN/m^2 (72 153.73 PLN)	200.66 PLN/m^2 (197 852.02 PLN)
1 January 2014	73.27 PLN/m^2 (69 602.18 PLN)	201.67 PLN/m^2 (198 845.09 PLN)

The summary presented in Table 6 allows to compare both the study areas with each other, as well as to trace the changes in the price of the same property (with the same attributes) within the particular database at successive points in time. Basing on the above illustration, the following conclusions can be drawn:

- In the study area in the district of Kielce, it can be noticed that the unit market value of the test property has increased by about 20 PLN/m² in the period between 2006 and 2010. Despite the small size of the database KIE-1 (and thus its imperfection) covering the transactions concluded in the years 2004–2005, the valuation as of 1 January 2006 can be assumed to be correct, and therefore the occurrence of the increase in the value of real properties on the market during this period can be assumed as well. A similar situation occurs in the database KRA-1, where we are dealing with a price increase by over 100 PLN/m² (from about 87 to about 201 PLN/m²). Therefore, a rapid upward trend in both studied real estate markets can be observed. The scale of the increase in the value probably depends on the demand, which in the city such as Krakow, with about 750 thousand inhabitants, will be much greater than in Kielce, which is the city of a little over 200 thousand inhabitants.
- Comparing the values of the test properties in both study areas as of 1 January 2010 and 1 January 2014, a slight decline was noticed in the case of the database KIE, while in the case of the database KRA, a minimal increase in the current unit price was noted, compared to 2010. These differences are as follows: in the database KIE – the price decreased by 2.68 PLN/m², in the database KRA – the price increased by 1.01 PLN/m². These differences are small, and therefore it can be assumed that there is some stabilization in the prices on the real estate market.
- The price of a comparable test property in the district of Krakow is always higher than in the district of Kielce. It obviously results from a much greater demand for this type of properties in close proximity to a large, much better economically developed city (Buśko, Przewięźlikowska 2016).
- Between the simulations of the valuations in the years 2004–2005 and 2008–2009, there was a soar in the values of this type of properties (especially in the case of the real estate located in close proximity to Krakow). Thus, it may be concluded that, in the further research, it would be worthwhile to focus more on the period of 2005–2008. Valuations at, for example, 1-year intervals, in relation to the then existing economic situation, could provide information why there was such a great "price shock", and whether it really was dramatic and caused by specific events (such as global financial crisis), or whether it was a large but steady increase over the period of 4 years.

Yet another occurring conclusion is that the current market unit price of land in the district of Kielce is approaching the price from 2006 in the district of Krakow. The relatively young market of single-family housing near Kielce takes after the Krakow market after the year 2000. It can be assumed that the intensively extending city of the Świętokrzyskie province will determine the development of the studied real estate market. It will not necessarily reach the price level of the "urban bedroom" market of Krakow, but the trend will certainly continue upward. It is difficult to determine the dynamics of the growth, however, because the current prices remain stable, or even are slightly decreasing (which is also noticeable in the cross-correlation diagrams of the attributes of price and time). There is high probability, though, that further price increase and the development of the market will take place in the next years, just like it is in the case of the neighboring Krakow market.

Comparison of the descriptive statistics of individual real estate databases

The data summarized in Tables 7 and 8 confirm the conclusions drawn in the preceding section. These statistics characterize particular data sets, referring only to the collected information on market transactions. For most data-

bases, without taking into account the price-determining attributes (shape of the plot, location, environment, communication, fashion), these data may also serve as a confirmation of the results of the prepared simulations of the test property valuations.

Data sets are sufficient to carry out the valuation of the property (a limit of at least 30 properties in the database was established). The exception is the database KIE-1. In this case, it was not possible to obtain more information on the concluded transactions. Before 2006, the District Office in Kielce did not run a comprehensive record of transactions in the computer system, and it was not possible to get access to the notarial deeds stored in the archives.

Having analyzed and compared the results contained in Tables 7 and 8, it may be noted that:

- The minimum and maximum transaction prices in the databases have a noticeable upward trend, however, it is not a general rule. The database of the transactions concluded in the years 2012–2013 does not necessarily have the highest value in these categories, or the database of the oldest transactions (covering the period of 2004–2005) does not have these parameters at the lowest level. It is not a rule, since the selection of the database should be made in such a way that the prices should vary. There might be a case that a database will contain properties which are more expensive and cheaper than the average. The only thing that remains then is the question of the rationality of such a price, for example when a real property is much more expensive but it also has much better attributes, at the stage of valuation there will be price adjustment per attribute unit to the average level.
- The parameter of the average real estate value in the database fully confirms the upward trend in the prices on the market. There is a noticeable upward trend in the average prices in the database in subsequent time intervals, both in the study areas in the district of Kielce and in the district of Krakow. In addition, the unit values of the test properties determined in the valuation process in subsequent simulations, correspond approximately to the average unit transaction price in the specific database. Naturally, average values do not always fall within the range of unit values determined by the method of interval estimation for the mean, due to the taking into account the diversity of real properties in terms of their attributes in the valuation process.
- Standard deviation of prices in the database gives the knowledge of the scatter of transaction prices in the database. In this way, it is possible to notice that the databases collected in the area of the Kielce district and the database KRA-1 are relatively consistent in terms of prices, while the database KRA-2 and KRA-3 are more varied. Firstly, this is due to the greater dynamics and irregularities in the modern real estate market of single-family housing in the district of Krakow. The large value of the standard deviation of the sample in the case of the databases KRA-2 and KRA-3 are confirmed by the illustration of a large price scatter in these databases. Accordingly, the database KRA-2 is indeed the most scattered, which is confirmed by the highest value of the standard deviation index.

Table 7. Statistics of the real estate databases in the Kielce district

District of Kielce					
DATABASE	Minimal transaction price [zł/m^2]	Maximum transaction price [zł/m^2]	Average value of transaction price [zł/m^2]	Standard deviation of prices in the database [zł/m^2]	Database size
KIE-1(2004-2005)	37.75	73.06	53.57 ± 2.86	11.0776	15
KIE-2(2008-2009)	25.00	100.00	58.54 ± 2.39	14.5070	37
KIE-3(2012-2013)	24.61	112.93	64.93 ± 3.83	22.6795	35

Table 8. Statistics of the real estate databases in the Krakow district

District of Krakow					
DATABASE	Minimal transaction price [zł/m^2]	Maximum transaction price [zł/m^2]	Average value of transaction price [zł/m^2]	Standard deviation of prices in the database [zł/m^2]	Database size
KRA-1 (2004–2005)	44.55	120.00	74.97 ± 3.47	19.9091	33
KRA-2 (2008–2009)	62.50	316.67	162.59 ± 11.68	67.6527	33
KRA-3 (2012–2013)	74.71	287.84	206.97 ± 9.68	55.6207	33

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