

## A STUDY OF REAL ESTATE MARKET IN KRAKÓW USING THE METHODS OF SPATIAL ECONOMETRICS

Agnieszka Bitner, Jakub Bysina

### Summary

The article presents implementations of statistics and spatial econometrics that can be used to study real estate market. The analysis covered the area of the administrative unit of Śródmieście district of Kraków. It is a very diverse area of research as it includes both the city core of Kraków and its outskirts. Śródmieście is divided into three districts: Stare Miasto, Grzegórzki and Prądnik Czerwony. The transactional data come from the notarial deeds drawn up in 2011. During that period 739 purchase/sale transactions of apartments were concluded. The purpose of the article is to create a map of the average prices of apartments situated in the administrative unit of Śródmieście. The analysis of the apartment prices was conducted both for the separate districts of cadastral registration (bounds, cadastral districts) and districts and for the whole administrative unit.

### Keywords

spatial econometrics • real estate market • statistical analysis • transaction prices • apartments • Kraków

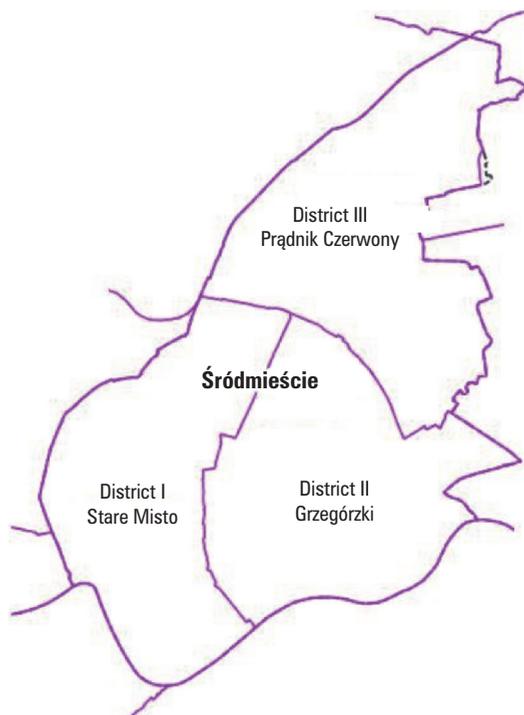
### 1. The characteristics of the studied area

Kraków is located in southern Poland, on the Vistula River. The area of municipality is 326.8 km<sup>2</sup>, which on 31 December 2011 was inhabited by 759 137 people. In 2011 the unemployment rate in Kraków varied from 4.5% to 5.0%, the average for Poland being around 12%. Kraków is conveniently located at the intersection of major transportation and communication routes connecting Western Europe with Eastern Europe (Frankfurt – Kiev) and Southern Europe with the Baltic Sea (the Gdansk – Budapest route) [Adamczewski 1992]. It is a university town. There are 24 higher education institutions in Kraków, such as: the Jagiellonian University, the Agricultural University, the University of Economics, the Pedagogical University, the University of Science and Technology, and the Technical University of Kraków. In the 2011/2012 academic year more than 180 thousand students studied at higher education institutions in Kraków [Szkolnictwo... 2012]. The scientific character of Kraków has a significant impact on the property market in this city. Kraków was divided into four administrative units: Krowodrza, Nowa Huta, Podgórze and Śródmieście (Figure 1), which are then divided into districts and bounds.



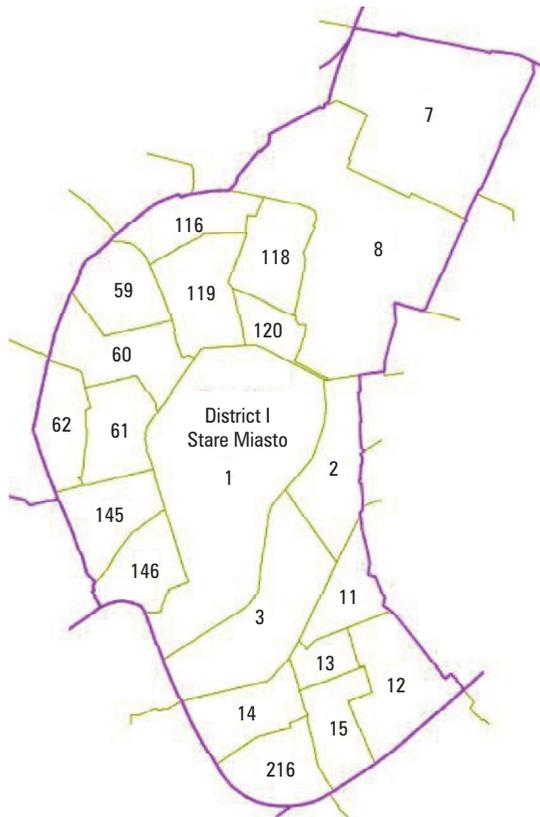
Source: [www.Krakow.pl/plan](http://www.Krakow.pl/plan)

**Fig. 1.** Administrative units in Kraków



Source: [www.Krakow.pl/plan](http://www.Krakow.pl/plan)

**Fig. 2.** The districts in Śródmieście



Source: [www.Krakow.pl/plan](http://www.Krakow.pl/plan)

**Fig. 3.** District I – Stare Miasto – division of the area in sections

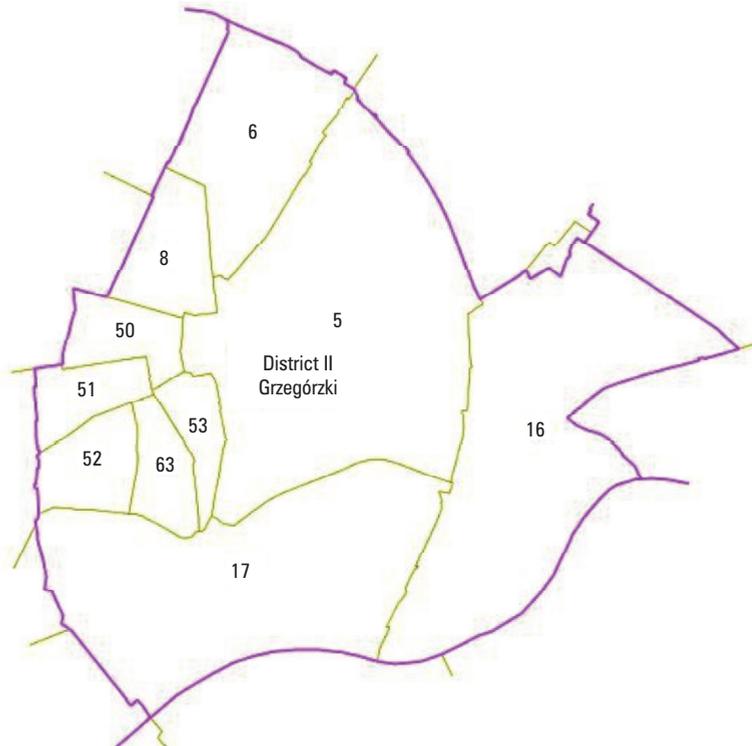
Administrative units consist of areas of grounds located within the administrative region of cities. In those cities where districts were created, the area of a district or of several neighbouring districts can be a administrative unit [Rozporządzenie... 2001]. This is also the case with Kraków. The cadastral district of Śródmieście, which is the subject of the study, consist of three districts: District I – Stare Miasto, District II – Grzegórzki, and District III – Prądnik Czerwony (Figure 2).

Each of the three districts consists of bounds. Similarly to administrative districts, bounds are units of the territorial division used for land and building registration purposes. The borders of bounds in urban areas correspond with district borders and, where possible, they overlap the borders of urban agglomerations, residential areas and the borders delimited by streets, watercourses, railway lines or other physiographical objects.

District I – Stare Miasto – consists of bounds with the following numbers: 1, 2, 3, 7, 8, 11, 12, 13, 14, 15, 59, 60, 61, 62, 116, 118, 119, 120, 145, 146, 216 (Figure 3). That

district includes the oldest parts of the city, in the first place the Wawel Hill, where a fortified city and the surrounding settlements were established in the ninth century, but also of poorly urbanized areas.

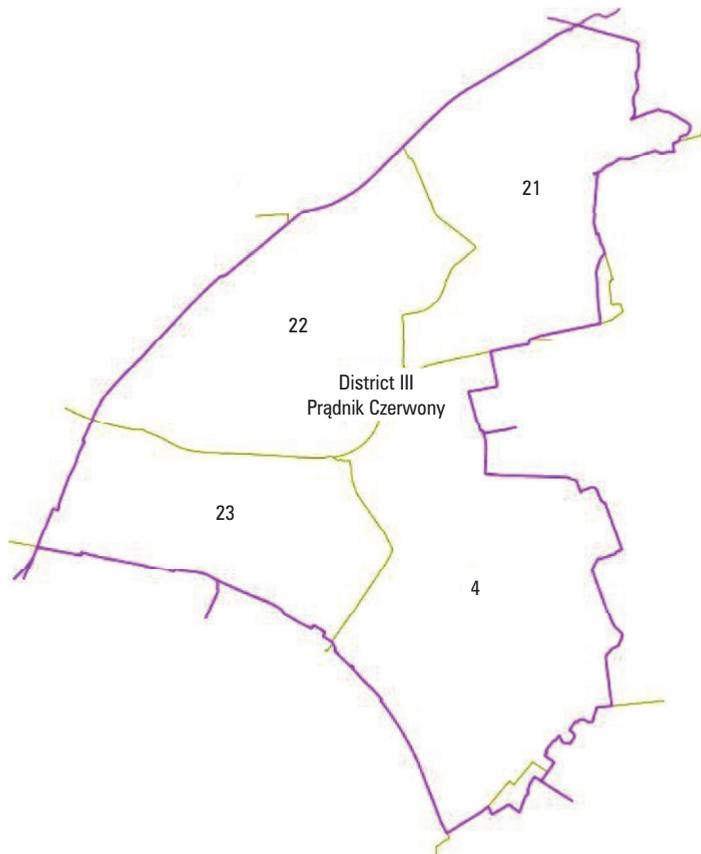
District II – Grzegórzki – consists of the following bounds presented in Figure 4: 5, 6, 8, 16, 17, 50, 51, 52, 53, 63. Formerly a village outside Kraków, which comes from the fourteenth century. In 1910 it became a part of the border of Kraków. In the territory of the district there is a botanical garden founded in 1783.



Source: [www.Krakow.pl/plan](http://www.Krakow.pl/plan)

Fig. 4. District II – Grzegórzki – division of the area in sections

District III – Prądnik Czerwony – consists of the following bounds: 4, 21, 22, 23 (Figure 5). Formerly a village outside Kraków, which was first mentioned at the beginning of the twelfth century as the areas belonging to the St. Benedict Monastery in Tyniec. At the beginning of the nineteenth century the Rakowicki Cemetery was founded in that area, and the Batowicki Cemetery in the twentieth century. In 1910 a part of the today's district became a part of the border of Kraków. The rest became a part of that border in 1941.



Source: [www.Krakow.pl/plan](http://www.Krakow.pl/plan)

Fig. 5. District III – Prądnik Czerwony – division of the area in sections

## 2. Characteristics of the database

In 2011 in the administrative unit of Śródmieście 739 sales were made. Transactions involving apartments in very poor condition, intended for general renovation, the price of which included a garage or a parking space, were not included in the database as well as the transactions, in which a company, a commercial enterprise, or a civil partnership was a party or where the parties were interrelated. Transactions that showed important data gaps, for example concerning the type of ownership rights to property, were not included in the analysis either. As a result the database consists of 589 records. The selection of data before applying the tools of spatial econometrics [Anselin 1988] is an essential step of the analysis of real estate market [Głuszak 2010, Bitner 2010].

### 3. The results of the analysis

Examining the apartments unit price trend in the analyzed period [Bitner 2003] was the first step of the statistical analysis of real estate market [Hozer et al. 2002, Adamczewski 2011, Bartuś et al. 2009]. The analysis carried out for both the whole administrative unit of Śródmieście and for its separate districts showed that apartment market was stable. The prices were relatively similar.

The average unit price of apartments in Śródmieście was 7469.78 zloty · m<sup>-2</sup>. The maximum price of 17551.42 zloty · m<sup>-2</sup> was noted in District I – Stare Miasto, in the bounds 62, in Cybulskiego St. That flat is located in a building with a high standard of finishing and situated in an attractive area. The lowest price of 3458.21 zloty · m<sup>-2</sup> was noted in District III – Prądnik Czerwony, in the bounds 23, in Wieniawskiego St.

Table 1 and Figure 6 show the distributions of apartment unit prices in Śródmieście. The division into 10 price ranges (classes) of 1410 zloty · m<sup>-2</sup> was adopted.

**Table 1.** The distribution of apartment unit prices

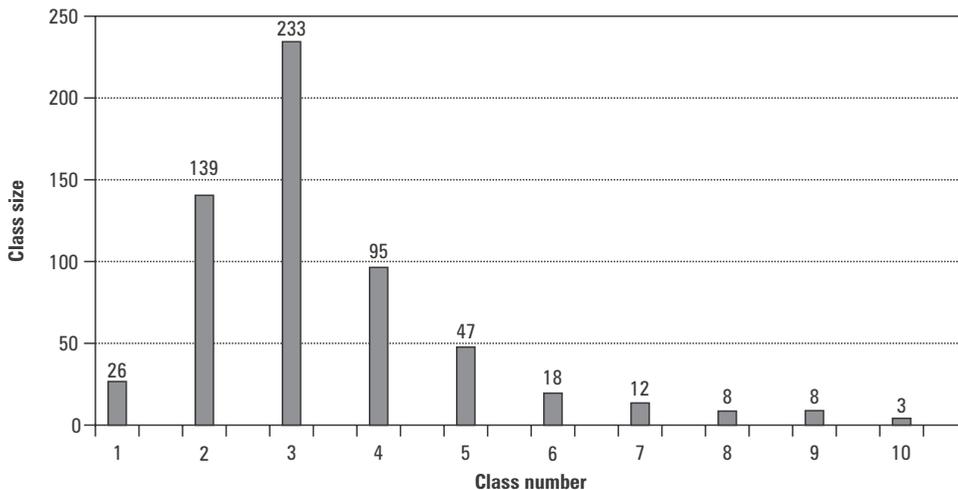
Class number	The lower class limit [zloty · m <sup>-2</sup> ]	The upper class limit [zloty · m <sup>-2</sup> ]	Number of sale transactions
1	3458	4868	26
2	4868	6278	139
3	6278	7688	233
4	7688	9098	95
5	9098	10508	47
6	10508	11918	18
7	11918	13328	12
8	13328	14738	8
9	14738	16148	8
10	16148	17558	3

Source: authors' study

Our analysis indicates that most of the transactions belong to the price range 6278–7688 zloty · m<sup>-2</sup>. They constitute almost 40% of all transactions on the market. The smallest amount of apartments sold was noted in the highest price ranges above 16148 zloty · m<sup>-2</sup>. The distribution of unit prices is asymmetric, skewed right.

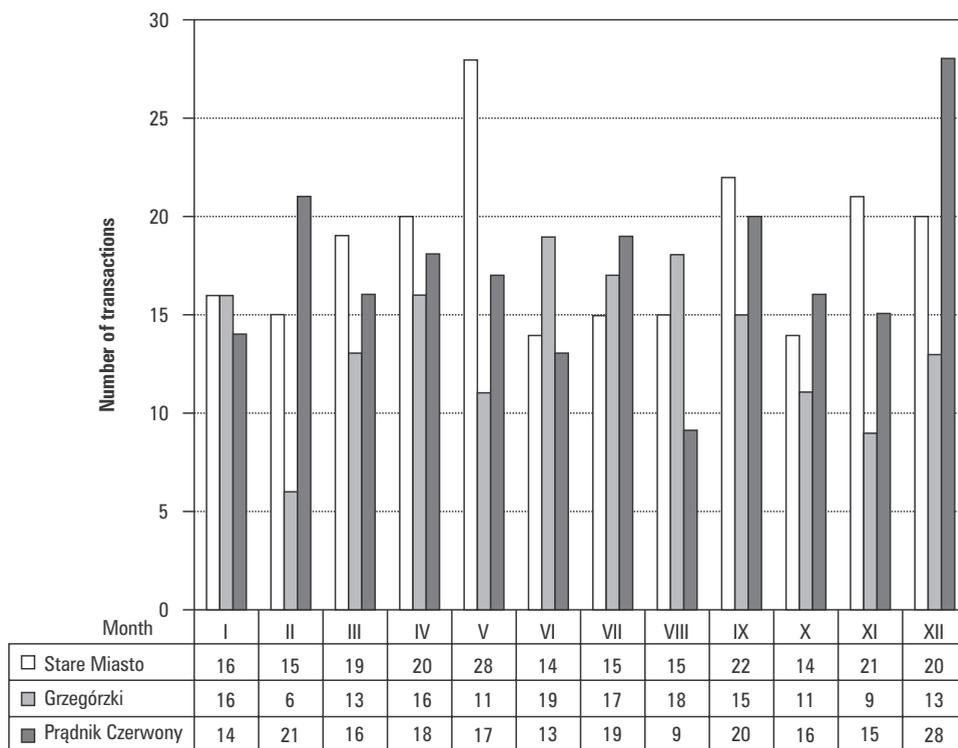
Figure 7 shows an overview of the transactions made in three districts in each month of 2011.

In the table in Figure 7 Roman numerals indicate the consecutive months, whereas Arabic numerals indicate the number of transactions. The biggest number of transactions was made in District I – 219 transactions, then of District III – 206, and the smallest number in District II – 164 transactions. The biggest number of transactions was noted in the third quarter of the year in December (61 transactions) and September



Source: authors' study

Fig. 6. The distribution of apartment unit prices



Source: authors' study

Fig. 7. Number of sales in districts

(57 transactions) and before the summer holiday in May (56 transactions). Large number of transactions in May and September is caused by the academic character of Krakow. High number of transactions in December reflects the customers' fear of changes in the apartment market in the new calendar year.

The analysis of prices in the individual bounds of Śródmieście was depicted in the cartogram showing price differentiations for that administrative unit. A map is the most transparent form of presenting spatial data [Howes 1980, Longley and Batty 1997, Kelsey et al. 2012]. Figure 8, thanks to differentiation of colours, presents the spatial distribution of apartment unit prices. The map of prices was drawn in a way that average prices were determined in each of bounds and they were grouped into seven price ranges. Table 2 provides the details of the division into classes.

**Table 2.** Division of bounds according to the price level

Class number	Number of bounds in each class	Price range [złoty · m <sup>-2</sup> ]	
		from	to
1	13	6136.00	7038.99
2	5	7039.00	7941.99
3	7	7942.00	8844.99
4	4	8845.00	9747.99
5	2	9748.00	10650.99
6	1	10651.00	11553.99
7	1	11554.00	12457.00

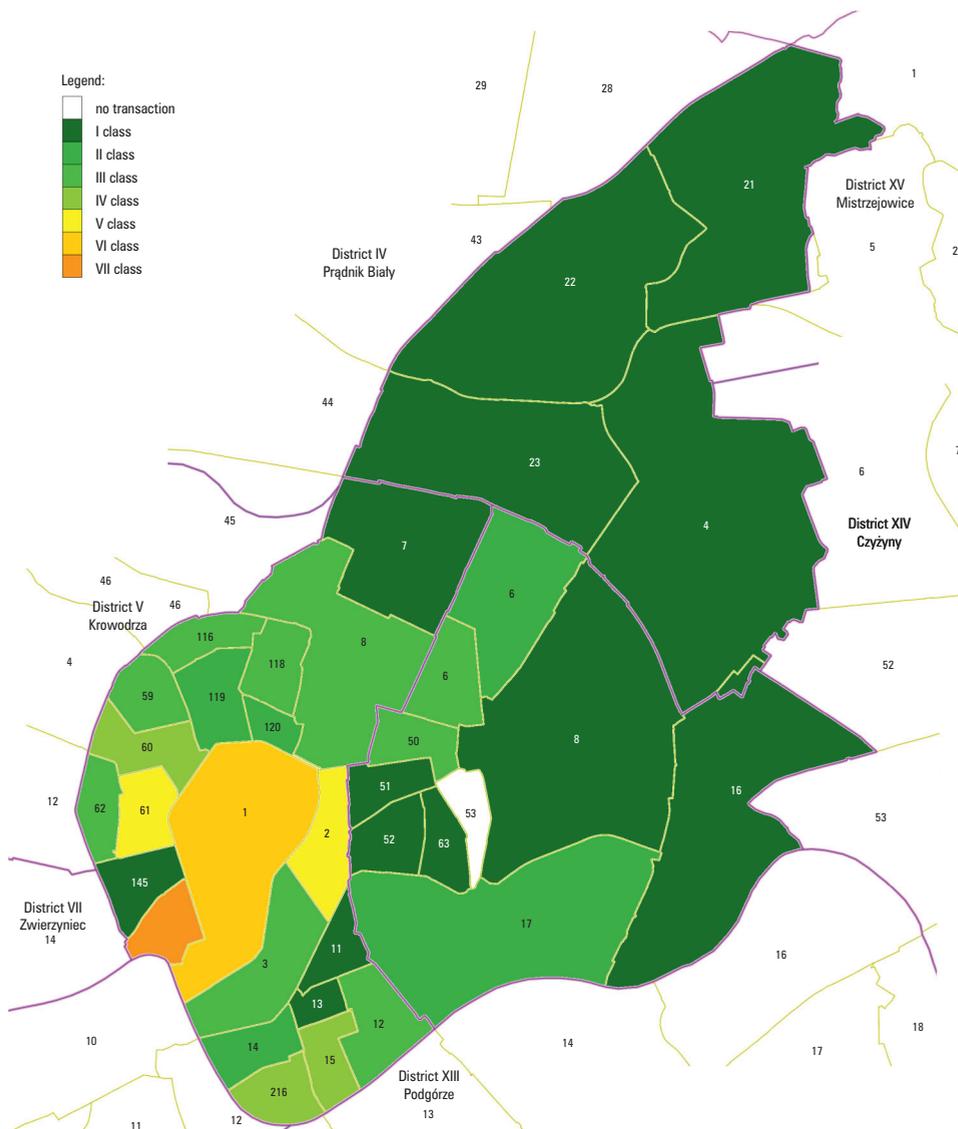
Source: authors' study

The cartogram shown in Figure 8 implies that the prices depend on the distance from the city centre. The longer the distance of a bounds from the Rynek Główny (the Main Market Square), the lower the average price of 1 m<sup>2</sup>. All bounds of District III – Prądnik Czerwony, most remote from the city centre, belong to the first price class. In District II – Grzegórzki – prices belong to classes 1–3. In one bounds marked by the white colour no transaction was noted – it is the Botanic Garden area.

Location in the vicinity of the Vistula boulevards is an important factor. The Vistula boulevards do not only protect from flooding, but they also serve recreational functions. There are many walking alleys and bicycle paths there, which attract both the citizens and tourists. A regularity has been observed that the closer the boulevards the higher the prices of the apartments. This is confirmed by the prices in bounds 17, 12, 15, or 216. The apartment houses situated in these bounds do not differ from those situated in the neighbouring bounds 11 and 13, with regard to age or finishing standards; but there is a considerable price differentiation.

The highest prices are found in District I – Stare Miasto. It is mostly due to the apartments' location in the centre of Kraków, the historical setting, and the beautiful,

historic apartment houses. The bounds located very close to the Wawel castle belong to the VII price class. The area surrounding Rynek Główny (the Main Market Square) belongs to the VI price class, despite its excellent location. It is due to very few transactions at very low prices for such location. In these cases poor technical condition of the buildings had a significant effect on the apartment prices.



Source: authors' study

**Fig. 8.** The cartogram showing unite price differentiations of apartments in Śródmieście

#### 4. Conclusions

The article focuses on using spatial econometrics for the analysis of apartment market. The goal of the project was to create the cartogram showing price differentiations of the apartments in the administrative unit of Śródmieście district of Kraków. Creating the cartogram was preceded by a thorough preparation of the database, from which 149 records were removed, resulting finally in the database of 589 transactions. The transactional data come from the notarial deeds drawn up in 2011. Then a statistical analysis was carried out, which was aimed at examining the prices levels of the apartments in Śródmieście. The analysis indicated that apartment market was stable in the analyzed period. The cartogram was created using the average transactional prices in the individual bounds of the analyzed administrative unit. The price range thus obtained was divided into 7 price classes, which correspond to 7 different cartogram colours.

The analysis of a spatial distribution of the prices indicated that the distance from the city centre, the neighbourhood, and the technical condition of the buildings have the biggest impact on the level of apartment prices.

#### References

- Adamczewski J. 1992. Kraków od A do Z. Krajowa Agencja Wydawnicza, Kraków.
- Adamczewski Z. 2011. Elementy modelowania matematycznego w wycenie nieruchomości. Oficyna Wydawnicza PW, Warszawa.
- Anselin L. 1988. Spatial Econometrics: Methods and Models. Kluwer Academic Publishers, Dordrecht, The Netherlands.
- Bitner A. 2003. Wskaźniki wzrostu cen nieruchomości gruntowych dla dużych rynków lokalnych. Materiały III Konferencji Naukowo-Technicznej PSRWN, Gdańsk.
- Bitner A. 2010. O użyteczności metod statystycznych w wycenie nieruchomości. Polska Akademia Nauk, Oddział w Krakowie, Infrastr. Ekol. Ter. Wiej., 12, 145–158.
- Bartuś K., M. Głuszak M., P. Krochmal P. 2009. Popyt mieszkaniowy w Krakowie. Preferencje nabywców mieszkań. Jesień 2009, Instytut Analiz Monitor Rynku Nieruchomości, Kraków.
- Głuszak M. 2010. Metody statystyczne w wycenie nieruchomości. Instytut Analiz Monitor Rynku Nieruchomości MRN.pl, Kraków.
- Howes C.K. 1980. Value Maps: Aspects of land and property values. Norwich, Geo Books.
- Hozer J., Kokot S., Kuźmiński W. 2002. Metody analizy statystycznej rynku w wycenie nieruchomości. PFSRM, Warszawa.
- Kelsey T.W., Adams R., Milchak S. 2012. Real property tax base, market values, and marcellus shale: 2007 to 2009. The Pennsylvania State University, CECD Research Paper Series.
- Longley P., Batty M. (eds.) 1997. Spatial Analysis: Modelling in a GIS Environment. Wiley & Sons, London.
- Rozporządzenie Ministra Rozwoju Regionalnego i Budownictwa z dnia 29 marca 2001 r. w sprawie ewidencji gruntów i budynków. Dz.U. z 2001r. Nr 38, poz. 454.
- Szkolnictwo wyższe w województwie małopolskim w 2011 r. Urząd Statystyczny w Krakowie, sierpień 2012.

---

Agnieszka Bitner  
Uniwersytet Rolniczy w Krakowie  
Katedra Geodezji Rolnej, Katastru i Fotogrametrii  
30-198 Kraków, ul. Balicka 253 a  
e-mail: rmbitner@cyf-kr.edu.pl

Jakub Bysina  
Absolwent Wydziału Inżynierii Środowiska i Geodezji  
Kierunku Geodezja i Kartografia  
Uniwersytet Rolniczy w Krakowie  
e-mail: kuba\_bysina@tlen.pl