

Czerski, Jaroslaw; Gluszak, Michal; Zygmunt, Robert

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**Repeat sales index for residential real estate in Krakow**

Jarosław Czerski, Michał Głuszak, Robert Zygmunt

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Jarosław Czerski<sup>1</sup>, Michał Głuszak<sup>2</sup>,  
Robert Zygmunt<sup>3</sup>

Authors listed in the alphabetic order

<sup>1</sup> [j.czerski@mnr.pl](mailto:j.czerski@mnr.pl); Instytut Analiz Monitor Rynku Nieruchomości mnr.pl, ul. Wybickiego 7c/312, 31-261 Kraków

<sup>2</sup> [gluszakm@uek.krakow.pl](mailto:gluszakm@uek.krakow.pl); Uniwersytet Ekonomiczny w Krakowie, ul. Rakowicka 27, 31-510 Kraków

<sup>3</sup> [rlzygmun@cyf-kr.edu.pl](mailto:rlzygmun@cyf-kr.edu.pl); Uniwersytet Rolniczy im. Hugona Kołłątaja w Krakowie, Aleja 29 Listopada 46, 31-425 Kraków

## Repeat sales index for residential real estate in Krakow

**JEL Classification:** C18, C43, R31

**Keywords:** *repeat sales index, Poland, housing market, house price, real estate*

### Abstract

**Research background:** There are several methods to construct a price index for infrequently traded real estate assets (mainly residential, but also office and land). The main concern to construct a valid and unbiased price index is to address the problem of heterogeneity of real estate, or put differently to control for both observable and unobservable quality attributes. Most frequently used is probably hedonic regression methodology (classic, but recently also spatial and quantile regression). An alternative approach to control for unobservable differences in assets' quality is provided by repeat sales methodology, where price changes are tracked based on differences in prices of given asset sold twice (or multiple times) within the study period. The later approach is applied in famous S&P CoreLogic Case-Shiller house price indices..

**Purpose of the article:** The goal of the paper is to assess the applicability of repeat sales methodology for a major housing market in Poland. Previous studies used hedonic methodology or mix adjustment techniques and applied for major metropolitan areas. Most known example is a set of quarterly house price indices constructed by NBP – especially for primary and secondary market. The repeat sales methodology has not been adopted with significant success to date – mainly because of concern regarding relative infrequency of transactions on housing market in most metropolitan areas (thus potentially small sample of repeated sales)..

**Methodology/methods:** The study uses data on repeat sales of residential transactions in Krakow from 2003 to 2015. We apply different specifications of repeat sales index construction and compare respective values to hedonic price index for Krakow estimated by NBP.

**Findings:** Findings suggest that repeat sales house sales indices can be used to track price dynamics for major metropolitan areas in Poland. The study suggests problems that need to be addressed in order to get unbiased results – mainly data collection mechanism and estimation procedure.

## Introduction

In order to construct a valid and unbiased real estate price index is to address the problem of heterogeneity. In other words, the key issue is to control for both observable (measurable) and unobservable attributes (location, neighbourhood, structural and environmental). While difficult to build, real estate indices are extremely useful to investigate long-run economic processes. Among remarkable examples are Shiller's (2014, pp. 1486–1517, 2015) analysis of economic turbulences in US (1890–2014), Nicholas and Szczerbina's (2013, pp. 278–309) investigation into house price movement in 1920s and 1930s, not to mention historic studies of house prices in a long run in Netherlands (1628–1973) conducted by Eichholtz (1997, pp. 175–192), as well as China (1644–1840) conducted by Raff, Wachter, and Yan (2013, pp. 368–386). Two former studies have one thing in common – in both cases repeat sales methodology was used.

Repeat sales method of index construction is a way to account for unobservable differences in a given asset's quality by investigating price changes between sales. The method was introduced by (Bailey, Muth, & Nourse, 1963). The data requirements include the sample of real estate sold twice (or multiple times) within the study period. The modified repeat sales approach, based on a seminal paper by Case and Shiller (1987), has been applied in renowned S&P CoreLogic Case-Shiller house price indices. Although praised for theoretical soundness, the method has some limitations, one of them being the need for relatively active real estate market (thus large sample of repeat sales). It is by no means easy to suffice this particular data requirement on thin real estate markets. As the result, repeat sales methodology is rarely used as a method for applied index construction. To date, repeat sales house price index methodology has not been applied in Poland. The paper aims to address this gap, by analysing properties of residential repeat sales index in Krakow.

## Literature review

There is by no means a consensus regarding the methodology of real estate price construction. Nevertheless, in most cases two competing approaches, to deal with observed and unobserved heterogeneity of real estate have been used in the literature – i.e. hedonic and repeat sales methods. The difference between both methods has for long drawn attention of economist studying real estate price movements, mostly because in many cases they tend to produce incomparable insights into market volatility (Dorsey, Hu, Mayer, & Wang, 2010, pp. 87–105). Nevertheless, in most cases results remained inconclusive regarding the choice of appropriate house price index methodology (B. Case, Pollakowski, & Wachter, 1991).

The extensive summary of repeat sales methods of property price index construction provides a list of advantages and disadvantages of the technique (Prud'homme & Diewert, 2011, pp. 1–10). The list of former contains: limited data requirements, relative calculation ease, ease of reproduction, control for salient real estate characteristics (Prud'homme & Diewert, 2011, pp. 1–10), while latter can be contributed to: lack of depreciation correction, sample selection bias, data inefficiency, continuous revision problem (Prud'homme & Diewert, 2011, pp. 1–10).

The shift from classic house price indices towards a hybrid approach (Jones, 2010, pp. 95–97; Nagaraja, Brown, & Wachter, 2014, pp. 23–46), has been followed by other innovative solutions to the old problem of measuring the house prices dynamics.

Bourassa, Hoesli, and Sun (2006, pp. 80–97) tested sale price appraisal ratio (SPAR) method in New Zealand, and compared it to both hedonic and repeat-sales indices based on the same data. In the SPAR the ratio between transaction price and previously assessed property values is calculated. The SPAR house price index was also constructed using Dutch data (de Vries, de Haan, van der Wal, & Mariën, 2009, pp. 214–223). Others has addressed depreciation problem, and suggested techniques to disentangle pure time effect from property depreciation (Cannaday, Munneke, & Yang, 2005, pp. 320–342; Englund, Quigley, & Redfearn, 1998, pp. 175–192). In yet another article Francke (2010, pp. 24–52) analyzed the methods to estimate repeat sales index for a thin market

Recently scholars has begun advocating for more robust method of index estimation, especially in presence of outliers. Zhang and Yi used quantile regression approach to construct repeat sales index in Beijing (Zhang & Yi, 2017, pp. 85–96), and Gwangju, Korea (Yeon, 2016, pp. 260–267), while the others experimented with pseudo-repeat sales techniques based on matched data (Guo, Zheng, Geltner, & Liu, 2014, pp. 20–38).

Both hedonic and repeat sales indices are difficult to build, and update on regular bases. Institutional background of constructing real estate price index was described based on French experiences (Gouriéroux & Laferrère, 2009, pp. 206–213).

Real estate price index construction has been discussed in Polish economic literature. The selection of articles discussing various methodological issues include Foryś (2012, pp. 41–52), Kokot (2014, pp. 14–27, 2015, pp. 84–100), and Trojanek (2010, pp. 119–132, 2013, pp. 224–231). The most discussed and well-known house price index in Poland is published by National Bank of Poland. It has three major variants: (1) average, (2) median based as well as (3) hedonic index. The latter was discussed in Widłak and Tomczyk (2010, pp. 203–227). Recent developments on hedonic index construction, involving the regression splines and spatial methods to addresses spatial autocorrelation and smoothing issues was suggested recently (Widłak, Waszczuk, & Olszewski, 2015). To authors' best knowledge repeat-sales approach has not been applied on housing data in Poland, although an interesting adoption of the method to the art market was proposed by Kempa and Witkowska (2011, pp. 181–186).

## **Method of the Research**

## **Data sources and management**

Although there are multiple sources of information used to construct real estate price indexes - for example asking prices, sale prices, valuations (Pollakowski, 1995), for obvious reasons the choice is limited in case of repeat-sales index. The most valid and reliable source of information, although not always efficient in terms of information provided, are notary acts.

Our empirical data comes from database managed by Institute of Real Estate Market Institute mrn.pl, which is a professional organization of property valuers (Polish chartered surveyors), property market consultants and market experts. Based on address and land register we matched all transactions involving the same properties, and identified repeat sales from 4 quarter 2002 to 3 quarter 2015. As the research is focused on secondary market, we dropped all sales from the primary market (sold by developers) from the sample. As the result, we identified 2584 properties sold 2 times, 246 properties sold 3 times, 23 properties sold 4 times and 1 property sold five times during the study period. We decided to recode the data and match all transactions sold multiple times in pairs (first-second transaction). For example, information on 246 properties sold 3 times allowed us to create 492 repeat sales pairs. We used three-step sampling procedure.

Firstly, we eliminated all observations where the time difference between sales was less than 180 days, to eliminate abnormal transactions (Englund et al., 1998, p. 195).

In the second stage, we checked whether apartments did not change significantly between sales. All pairs, where properties undergone significant improvements were dropped from the sample.

Thirdly, we eliminated all properties with abnormal values or with additional clauses that significantly affect price (distressed properties, municipal sales, sale between relatives).

After data cleaning procedure we got our final sample (effective) of 2704 repeat sales. The comparison of basic descriptive statistics between sales and repeat sales samples reveals interesting differences. On average, the apartments in both repeat sales subsamples were smaller (average floor area of 46.6 or 47.1 sqm of usable space compared to 55.5 in the whole sample) and central locations were overrepresented.

## **Estimation procedure**

During data management phase we have prepared a dataset on residential properties  $n$  sold more than once over the study period  $t=0, \dots, T$ .

Within each pair we compare price at first sale  $p_n^s$  to the price at resale  $p_n^t$ . Due to data limitation (sample size) we decided to construct a quarterly residential properties price index. Repeat sales regression is based on a following specification (Balk, De Haan, & Diewert, 2011, p. 66):

$$\ln\left(\frac{p_n^t}{p_n^s}\right) = \sum_{t=0}^T \gamma^t D_n^t + \mu_n^t$$

where  $D_n^t$  is a time dummy variable (it takes value -1 in time period of the first sale, 1 in time period of the second sale, and 0 otherwise), whereas  $\mu_n^t$  is an error term.

Repeat sales index can be calculated based on regression coefficients (Balk et al., 2011, p. 67):

$$I^{0t} = \exp\left(\hat{\gamma}^t\right) \cdot 100$$

The model is subject to heteroskedasticity, thus several methods, alternative to standard OLS, were suggested to overcome this problem. Following guidelines from the literature we estimated three repeat sales indices, based on: (1) OLS, (2) WLS three-step procedure introduced by Case and Shiller (1987, pp. 45–56) and quantile estimation suggested by McMillen and Thorens (2006, pp. 567–584).

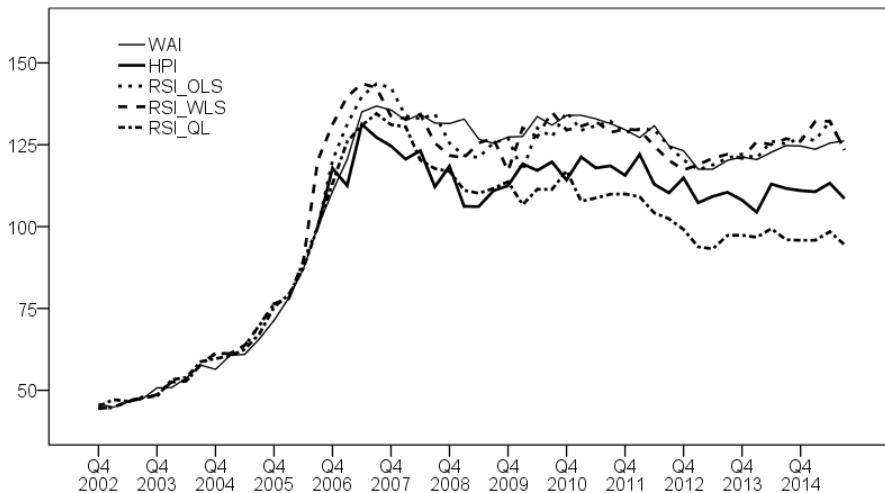
## Results and discussion

We investigated the price dynamics in Krakow using repeat sales dataset. Based on estimation procedures described in previous section we calculated three alternative repeat sales indices (RSIs) for residential properties in Krakow: baseline RSI\_OLS, weighted RSI\_WLS and quintile (median) RSI\_QL. Then we compared the results with the values of two benchmark indices – hedonic house price index for secondary market in Krakow calculated by (HPI), and simple weighted average residential price index based on full sample of mrn.pl data (WAI). Weighting was location based. Average prices were calculated based on transaction subsamples in 4 major districts in Krakow (Nowa Huta, Podgorze, Krowodrza and Srodmiescie). Weighting was based on transaction volume in the first period (4 quarter 2002). The comparison period ranged from 4Q 2002 to 3Q 2007. In

case of HPI the first index values come from 3Q 2006, which was set as a base period ( $I=100$ ) for all indices.

The results were presented in the Figure 1.

**Figure 1.** Comparison of residential real estate indices in Krakow (2002-2015)



Source: own calculations.

The results depict on figure 1 imply substantial differences between indices. Both RSI\_OLS and RSI\_WLS were in line with simple weighted average residential price index WAI. On the other hand, all three indices differed significantly from hedonic price index (HPI) calculated by NBP. The main difference can be attributed to higher price appreciation during housing boom period, and less apparent price decrease since the market peak in 2 or 3 quarter 2007. A quantile (median) repeat sales index (RSI\_QL) yielded different results, and suggested more rapid price decrease from the market peak in 3Q 2007.

## Conclusions

In the paper explored properties of repeat sales index for residential properties in Krakow. Based on a sample of 2704 repeat sales drawn from a larger transaction database, we estimated three repeated sales house price indices. The results were later compared to renown National Bank of Poland hedonic house price index for secondary housing market in Krakow and simple weighted average index based on a mrn.pl transaction database.

The results imply significant differences between repeat sales indices and NBP hedonic index – especially regarding market cycle. Repeat sales indices suggest that housing market peaked about 1 quarters later (in 3 quarter 2007). The results should be treated with caution. Although mrn.pl database is more detailed and significantly larger, the sample alone does not explain the differences found.

One concern regarding repeat sales index in Krakow is a sample selection problem. We found that properties sold twice or multiple times differed significantly from full sample of housing transactions, both in terms of size and location. On average they were smaller, and central locations were overrepresented.

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