THE APPLICATION OF THE SIMPLIFIED SPECULATIVE FRAME METHOD FOR MONITORING THE DEVELOPMENT OF THE HOUSING MARKET

Justyna Brzezicka

Department of Spatial Analysis and the Real Estate Market
Faculty of Geoengineering
University of Warmia and Mazury in Olsztyn
e-mail: justyna.brzezicka@uwm.edu.pl

Abstract

This article contributes to research into price dynamics on the real estate market. It proposes a simplified index-based speculative frame method for measuring above-average increases and decreases in real estate prices and monitoring market performance. The theoretical part of the article reviews the literature on the implications of real estate market stability on the economy, monitoring market development, and standard methods for analyzing the housing market with special emphasis on index-based methods. The experimental part of the article presents the results of a study analyzing more than 100,000 transactions on the Warsaw housing market between 2004 and 2015, a period characterized by a considerable increase in house prices. The price dynamics of apartments on the Warsaw real estate market was determined with the use of a time variable. The turning point in the market trend was identified. This article contributes to research into price dynamics on the real estate market.

Key words: housing market stability, bubble, speculative frame method, simplified speculative frame method.

JEL Classification: O18, R00, R21.

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1. Introduction

Price dynamics on the real estate market are difficult to measure, diagnose and forecast. At the same time, numerous studies indicate that the performance of the real estate market exerts a significant and direct influence on the financial sector; therefore, it is of considerable relevance for the economy. The experience of the global financial crisis of 2008 indicates that prognostic models had underestimated the difference between real prices and the fundamental value of housing, which led to the insidious development of speculative bubbles on many markets. These observations prompt the search for new methods for analyzing price dynamics on the real estate market. This article contributes to the research on speculative price bubbles. The aim of the study was to propose a simplified speculative frame method. The presented algorithm is an index-based method for calculating the change in the dimensions of a window denoting changes in house prices across selected time intervals. The present study analyzed the transactions on the housing market in Warsaw, the Polish capital and the largest Polish city, between 2004 and 2015, when house prices increased at a fast pace.

In addition to the simplified speculative frame method, a more advanced version of the approach, referred to as the speculative frame method, was also designed. The original method contains a
complex method for calculating the denominator of the house price index (Brzezicka, 2017; Brzezicka, Wiśniewski, 2021). The present article describes a related method with a simpler structure of the house price index to make it more accessible to researchers and market actors. Each method can be analyzed and applied independently. The present article deals with the simplified speculative frame method.

2. Literature review

The formation of price bubbles, a process involving above-average fluctuations in house prices, and its consequences to the entire real estate market and the financial sector prompt the search for new methods for monitoring market performance. The recent housing market bubble and the subsequent meltdown dealt a blow to sustainable homeownership in the United States (Turcu, 2012). The rapid rise in housing prices reduced housing affordability. An expansion of high risk mortgage lending fueled and helped sustain the rise in house prices. The episode has reduced household creditworthiness and prompted a procyclical response - increased capital assessments and tightened credit standards in mortgage credit markets – making entrance or return to homeownership more difficult for many families (Turcu, 2012). The shift between demand and supply is directly responsible for price bubbles. According to MacDonald (MacDonald, 2012), “a significant mismatch between supply and demand leads to an unsustainable housing market”. In the short-term and the long-term perspective, economic stability is a component of a sustainable housing market. Sustainable growth of the housing market and economic stability prevent social exclusion (Wang, 2019). State interventions aiming to promote sustainability in housing planning (MacDonald, 2011), urban regeneration schemes implemented by the local authorities (Jones & Wakins, 2001), the stabilizing impact of interest rates on housing prices (Bui, 2020), social forces (Li et al., 2019) and other social determinants of residential development (Stephens, 2012) contribute to the provision of sustainable and affordable housing (Adabre & Chan, 2019; Mulliner et al., 2013) and sustainable management of land resources (Marks-Bielska, 2011; Zrobek et al., 2020), as well as promote the monitoring of the real estate market (Turcu, 2012; Calem et al., 2011). Any concept of sustainable development, in particular on the housing market, has to incorporate sectoral concepts; it has to ensure that these concepts are well integrated in the overarching urban, regional and governance policies (Tosics, 2004), and that data are absorbed from many different sources (Walacik et al., 2020). In this context, the price index calculated with the simplified speculative frame method can substantially contribute to the effective monitoring of the real estate market. The proposed approach has a simple methodological framework, and it can be used as a simple scoring tool to provide quick information about market performance. The developed method eliminates the need for complex econometric models which are necessary to acquire detailed information about the structure and processes that govern the housing market.

The search for new methods for analyzing the real estate market is particularly justified because the housing market influences the stability of the entire financial sector. The boom-bust episodes, which often ended in a crisis, are often generated by house price swings (Duca et al., 2010; Cesa-Bianchi, 2013). Duca (2010) focused on the key aspects of the interplay between financial innovations and housing in generating and propagating the global financial and economic crisis. Other researchers also emphasized the global impact of real estate market shocks (Hirata et al., 2012; Cesa-Bianchi, 2013). Cesa-Bianchi (2013) confirmed the existence of strong international spillovers to advanced economies from demand shocks on the US housing market. The long-term relationship between house prices and economic variables was analyzed by many authors (Abraham & Hendershott, 1994; Malpezzi, 1999; Mayer et al., 2002; Lee & Song, 2015). Abraham and Hendershott (1994) divided the determinants of real house price appreciation into two groups. The first group includes the growth in real income and real construction costs and changes in the real after-tax interest rate, whereas the second group consists of lags in the real estate sector and the difference between the actual and equilibrium prices of real estate. The second group of factors is particularly important for the objectives of the present study. The difference between the actual and equilibrium prices is the main driver of price underestimation, and it often determines the dynamics of house prices.

Equilibrium housing prices denote the fundamental value of real estate (Tyc, 2013), and any deviations from that equilibrium result in an above-average rise in real estate prices and the formation of price bubbles (Stiglitz, 1990; Flood & Hodrick, 1990; Brzezicka, 2021). The fundamental value can be expressed as the sum of discounted cash flows on the real estate market (Smith & Smith, 2006; Fraser et al., 2008; Mikhed & Zemčík, 2009) or legal, institutional, economic and social factors that determine
the performance of the real estate market and constitute its foundations (Malpezzi, 1999; Black et al., 2006; Mao & Shen, 2019). However, the main difficulty in analyzing house price dynamics is that the fundamental factors are often insufficient to diagnose current market trends and predict future trends. There is considerable research evidence to suggest that house price dynamics often exceed the price levels determined by economic fundamentals (Xiong, 2013) such as population growth, personal income, housing construction costs, rents and interest rates (Case & Shiller, 2003; Gallin, 2006; Mikhed & Zemčík, 2009). Many authors have also argued that mainstream macroeconomic models had failed to predict credit crises and economic recessions (Bezemer, 2009). Both approaches to market fundamentals, including the narrow approach - based on the current value, and the broad approach - based on fundamental factors, are separated by the time horizon in the research design. According to Brzezicka (2021), the approach based on the net present value (NPV) is future-oriented, whereas the approach based on models of fundamental value where real estate prices are explained by variables is based on historical data series. In the literature, the second approach has been most widely used to diagnose price dynamics on the housing market. At the methodological level, the second approach relies on standard econometric methods, such as multiple regression models, co-integration models and autoregressive models.

The time horizon adopted in research studies can be problematic because it has to account for the real time of market analyses, which has important implications for market research (Wang et al., 2018) and housing policy. Real estate developers are unable to respond to the current demand for housing from potential customers in real time (Tomal, 2020b). As a result, information reaches the market with a certain time lag, which leads to delays in information discounting by market participants, and, consequently, delays resulting from the length of the investment process. Market analyses involving econometric methods require long time series. Econometric models do not flexibly respond to current and actual price dynamics. The problem of real time has been effectively addressed by the rolling window approach proposed by Swanson (Swanson, 1998), the moving window method (Phillips et al., 2015a; Phillips et al., 2015b), the rolling regression approach, and the rolling window method in vector error correction models (Damianov & Escobari, 2016). However, these advanced econometric models were not used in the present study. The acquisition of long-term data series is often problematic in Poland (compare to Trojanek 2021). The Polish real estate sector is a young market (Łaszek et al., 2016) that was initiated by the political and economic transformations of 1989-1990. The Polish market is currently in the self-regulatory phase, which contributes to disequilibrium and low market effectiveness (Brzezicka et al., 2018). Registers of real estate prices are kept by local governments. These data often reach the local administration with a delay, and are incomplete, in particular in early stages of market evolution. Real estate market data have to be published regularly, and real-time data contribute to the transparency of the real estate market (Taylor, 2007).

Indicator-based techniques constitute a separate group of methods for analyzing the real estate market and identifying price bubbles. These approaches support observations of change dynamics by comparing current indicator values with their long-term average value. They include affordability ratios (Hulchanski, 1995; Malpezzi, 1999; Black et al., 2006) and index based-methods which will be discussed in greater detail in this article.

Two real estate price indices are regularly published in Poland. The first is the house price index that has been compiled by Statistics Poland since 2015. The house price index is published within four months after the end of each quarter, where the previous quarter equals 100. The index does not contain highly detailed data, and it is calculated for the entire country and for each Polish voivodeship. The second index is published by the National Bank of Poland. It contains information about average transaction prices and selling prices on primary and secondary real estate markets in the 16 largest Polish cities and urban agglomerations. The index agglomerates average quarterly data that are published with a quarterly delay. Expert reports are also generated, but they reach a small group of market users or are available at an additional charge. For this reason, some researchers collect current data with the use of web scraping techniques (Tomal, 2020a). In contrast, several house price indices are generated and regularly updated on the US market, including two median house price indices and three repeat sales indices (Askitas, 2016). In repeat sales indices, price changes are tracked based on differences in the price of an asset that was sold twice (or multiple times) within the study period. Median house price indices are aggregate measures of house prices in a given period of time, and they are based on median or average values. Repeat sales indices are developed by the National Association of Realtors (NAR) and the Census Bureau (CB), whereas median house price
indices are compiled by the Federal Housing Finance Agency (FHFA), CoreLogic (CL) and S&P/CaseShiller (S&P/CaseShiller Home Price Index).

Index-based methods are widely used in Poland to measure real estate price dynamics. The relevant methods and limitations have been broadly discussed in the Polish literature (Foryś, 2012; Foryś, 2016; Hill & Trojanek, 2020). Kokot (2014; 2015a) relied on the median house price index to calculate chain indices for apartment prices in Szczecin in 2006-2014 based on median values of the selling price in the interval for which the index was calculated. Several attempts were also made to calculate the repeat sales index on the Polish housing market (Czerski et al., 2017; Głuszak et al., 2018), but the repeat sales methodology has not been adopted with significant success to date, mainly due to the relative scarcity of housing transactions in metropolitan areas and small samples of repeat sales (Czerski et al., 2017). Sample selection bias is one of the greatest limitations in this group of methods, in particular on young markets. Hedonic indices (hedonic regression and, more recently, spatial hedonic regression models) are also popular in Poland. These models rely on the hedonic function, i.e. the relationship between the price of an asset and its characteristics. These relationships are often investigated in hedonic regression analyses. Hedonic models have been deployed to explore the housing market in Warsaw (Tomczyk & Widlak, 2010; Widlak & Tomczyk, 2010; Widlak et al., 2015; Trojanek, Huderek-Glapska, 2018; Trojanek et al., 2021), the commercial real estate market in Warsaw (Leszczyński & Olszewski, 2017), as well as real estate markets in other large Polish cities, such as Poznań (Trojanek, 2009). Spatial hedonic regression models (Cellmer, 2013; Renigier-Bilozor et al., 2019; Tomal, 2020a) and the quantile spatial regression approach (Tomal, 2019) have been used in recent research on hedonic price indices in Poland. The efficiency of fuzzy logic and regression models was presented and compared by Renigier-Bilozor (Renigier-Bilozor et al., 2019).

The development of a reliable house price index is a challenging task, mainly due to the heterogeneous character of the residential market (Trojanek, 2007; Belej, 2016; Galati & Teppa, 2017; Cellmer, Trojanek 2019) differences in home characteristics, and the limited availability of detailed data on the housing market. A hedonic index is difficult to design for two main reasons. The first is the change in the quality of goods when selected items in the basket are replaced with new items (Tomczyk & Widlak, 2010). The second reason is the relatively low number of transactions, which compromises the selection of a representative sample in each analyzed period (Kokot & Dosiżyń, 2018). As a result, the transactions concluded in successive periods involve real estate of different quality (Kokot, 2015b). The presented literature review indicates that real estate price indices on the housing market are usually developed with the use of hedonic, repeat sales, and median house pricing approaches.

3. Data and Methods

The speculative frame method is an index-based approach for analyzing house price dynamics over time. The speculative frame is a quantitative research category for analyzing market performance based on window dimensions. The variable vertical dimension of the window denotes the rate at which housing prices change over time, whereas the fixed horizontal dimension represents time. In this study, the horizontal dimension was constant because the analysis was conducted in a specified period of time. The vertical dimension varied over time due to the heterogeneity of housing prices. The variability of the vertical parameter follows from the variability of the real estate market where simple statistical measures for building aggregate indicators, such as the mean and the median, change over time. For this reason, the speculative frame method can be used to describe price dynamics and to identify and diagnose market shocks, speculative bubbles and other disruptions. In this approach, the difference between the value of a transaction and any other transaction concluded in the same period of time (such as a month), excluding transactions conducted on the same day, is calculated, and the result is used to determine the change in housing prices in the analyzed period.

In the approach, the first transaction concluded in the analyzed period (or the mean price of the transactions concluded on the first day) is expressed by the relationship between price and the time until the next registered transaction. The vertical dimension of the window is calculated based on the daily change in housing prices $DC$ with the use of formulas (1), (2), (3) and (4). Formula (5) is used to calculate the mean change $DC$ in each period (for example, a month). Time was expressed in days, where 1 January 1900 was denoted as day 1, 2 January 1990 was denoted as day 2, and so on, according to MS Excel functions.
\[ DC_1 = \frac{x_p - x_0}{t_p - t_0} \]  
\[ DC_2 = \frac{x_1 - x_0}{t_1 - t_0} \]  
\[ DC_3 = \frac{x_2 - x_0}{t_2 - t_0} \]  
\[ DC_m = \frac{x_m - x_0}{t_m - t_0} \]  
\[ DC_{Sm} = \frac{DC_1 + DC_2 + \cdots + DC_{N-1}}{N-1} = \frac{\sum_{n=1}^{N-1} DC_n}{N-1} \]  

where: \( DC_1, DC_2, DC_3, \ldots, DC_m \) – increase in individual transaction prices \( n \in \{1, 2, 3, 4, 5, \ldots, N - 1\} \); \( DC_{Sm} \) – mean price change in period \( m \) for \( m \in \{1, 2, 3, 4, 5, \ldots, M\} \); \( x_0 \) – first price in each time interval, first point in the window; the time interval denotes the analysed period, such as a month; \( x_1, x_2, \ldots, x_N \) – successive prices in the analysed period; \( t_0 \) – date of the first transaction in each time interval expressed by numbers in a given order; \( t_1, t_2, \ldots, t_N \) – dates of subsequent transactions, excluding date \( t_0 \), in each time interval; \( N \) – number of transactions/last transaction in the analysed interval; \( M \) – number of the analysed periods and the last analyzed period; \( p \) – number of transactions between the second and the last day of the adopted time interval.

In the developed approach, only the first transaction in the analyzed period is taken into consideration. However, many more transactions are usually concluded in a single day. This problem was addressed by replacing the price of the first transaction with the mean price of all transactions concluded on the first day of the analyzed time period. The method examines the relationship between the mean price of the transactions conducted on the first day and the dates of the remaining transactions in the analyzed period. This approach eliminates the problem of numerous transactions on the first day of the analyzed period, and it weakens the significance of the first transaction. The mean price of the transactions concluded on the first day of every analyzed time interval is calculated as the arithmetic mean or the geometric mean.

The following categories related to a dynamic increase in values were introduced: cumulative increase \( DC_{sd} \) and increase rate \( RD_{Csd} \). Cumulative increase \( DC_{sd,m} \) represents the cumulative increase in period \( m \) (\( DC_{Sm} \)), and it is calculated with formulas (6) and (7). In the first period \( (m = 1) \), cumulative increase \( DC_{sd,1} \) is equal to the mean increase in the first period \( DC_{S1} \) (formula (6)). Cumulative increase \( DC_{sd,m} \) was used to develop an additive model based on the observed increase in prices.

\[ DC_{sd,m} = DC_{S1} \text{ for } m = 1 \]  
\[ DC_{sd,m} = DC_{Sm} + DC_{sd,m-1} \text{ for } m > 1 \]  

where: \( DC_{sd,m} \) – cumulative increase in period \( m \), where \( m \in \{1, 2, 3, \ldots, M\} \); \( DC_{S1} \) – first mean increase in period \( m = 1 \); \( DC_{Sm} \) – mean increase in period \( m \), where \( m \in \{1, 2, 3, 4, 5, \ldots, M\} \).

A qualitative tool for identifying and measuring price dynamics, \( RD_{Csd} \), was developed in the next step. This indicator denotes the relationship between the variable vertical dimension of the window representing the increase in prices and the fixed horizontal dimension of the window denoting time. This relationship is described by formula (8).

\[ RD_{Csd} = \frac{DC_{sd,m} - DC_{sd,m-y}}{y} \]  

where: \( RD_{Csd} \) – relationship indicators. These indicators describe the variability in prices, and they are used to determine the decrease / increase in transaction prices; \( y \) – period during which the variability in prices is observed. The remaining symbols are identical to those described in the previous formulas. Period \( y \) can be determined for a continuous chain of calculation sequences.

The proposed approach was validated on the example of Warsaw, the Polish capital and the largest Polish city. The database for the analysis was obtained from the AMRON Centre for Analyzing and Monitoring the Real Estate Market. The database was released by AMRON solely for research purposes, and it did not contain personal data relating to property sellers or buyers, real estate attributes, or exact locations. Only apartment transactions were analyzed. Despite the absence of information about price attributes or parties to the concluded transactions, the AMRON database was selected because it covers a long period of time (2004 to 2015) which was characterized by a
considerable increase in real estate prices and the creation of a speculative price bubble in Warsaw and other large Polish cities. The Register of Real Estate Prices and Values is the most comprehensive source of data on the Polish real estate market. The register for the city of Warsaw was created in 2006, but it was deficient in data in the first years after its establishment. Before 2006, detailed data were not collected or were recorded in non-editable format and could not be analyzed. For these reasons, the AMRON database was used in the study. The database covered more than 100,000 transactions (108,089) concluded between 1 January 2004 and 17 December 2015. However, the data for the last six months of the investigated period are incomplete due to a lower number of transactions; therefore, the results of the analyses pertaining to that period should be considered with caution. The mean monthly price and the number of transactions are presented in Figure 1.

4. Empirical results

Successive changes in transaction prices were calculated on a monthly, quarterly and annual basis. The calculations were performed with the use of an algorithm where the arithmetic mean represented the mean price of the transactions concluded on every successive day of the analyzed period. Alternative calculations were conducted with the use of the geometric mean. The cumulative increase in transaction prices \( DC_{sd} \) was presented on a monthly basis in Figure 2, on a quarterly basis in Figure 3, and on an annual basis in Figure 4 (next page).

The results indicate that cumulative increase \( DC_{sd} \) follows the direction of the arithmetic mean calculated for the analyzed period. The presented method is sensitive to changes in house prices. In the analysis of monthly data, \( DC_{sd} \) is greater than one, which implies that standard deviation exceeds the mean value of the entire data series. The coefficient of variation was determined at 0.65 in analyses of quarterly data and at 0.68 in analyses of annual data. The high variability of monthly data resulted from a highly dynamic increase in housing prices, and it is not free of random errors. A considerable decrease in housing prices was observed at the turn of April and May 2005. This one-off decrease was captured by the developed method. Indicator \( DC_{sd} \) represents the cumulative increase in prices (\( DC_{s} \)); therefore, a single significant change in \( DC_{s} \) was reflected in the value of \( DC_{sd} \). This change is not visible in the analysis of quarterly prices. The values of \( DC_{s} \) in analyses of monthly and quarterly data between 2004 and 2006 (36 months, 12 quarters) are presented in Figures 5 and 6, respectively.
Fig. 2. Cumulative increase DCsd on a monthly basis. *Source:* own study.

Fig. 3. Cumulative increase DCsd on a quarterly basis. *Source:* own study.

Fig. 4. Cumulative increase DCsd on an annual basis. *Source:* own study.
The aim of the speculative frame method is to present house price dynamics with the use of a single indicator. This goal is achieved by calculating index $R_{DCsd}$ which expresses the relationship between the variable vertical dimension of the window denoting the rate of increase and the constant horizontal dimension of the window representing time. The value of $R_{DCsd}$ was calculated with the use of formula (11). The period characterized by variable price change ($y$ constant) covered 3 time intervals. In analyses of monthly data, 3 time intervals represented 3 months or one quarter, whereas in analyses of quarterly data, 3 time intervals represented 3 quarters or 9 months. Index $RCsd$ was not calculated for annual data because such a long time horizon would not contribute detailed information about the real estate market. Index $R_{DCsd}$ calculated for monthly data is presented in Figure 7, and for quarterly data – in Figure 8. Monthly data were characterized by high values of $R_{DCsd}$, which is a natural consequence of the high values of $DCs$ and $DCsd$ in the monthly approach. Index $R_{DCsd}$ effectively captured the above-average change in prices. The analyses of both monthly and quarterly data revealed an increase in house price dynamics between 2006 and 2007. The proposed method is not only sensitive to an above-average increase in prices, but also to a decrease in prices. The value of $R_{DCsd}$ decreased below zero in analyses of monthly data for 2010 and 2012-2013, and it also decreased in analyses of quarterly data for 2011-2013, which is consistent with price adjustments.
3. Discussion
The discussion of the results will address several issues. The author is aware that the simplified speculative frame method is not ideal and has several limitations. In this study, numerous tests and simulations were conducted to validate the method on various datasets.

Firstly, the proposed method makes a reference to the first transaction, and the results can be distorted by the value of the first transaction. To minimize this effect, a method for calculating the mean value of the transactions conducted on the first day was incorporated into the algorithm. The arithmetic mean or the geometric mean was used. The geometric mean is less sensitive to extreme values than the arithmetic mean, and it can be used to explore the change dynamics of various phenomena. The increase in $DC_{sd}$ calculated with the geometric mean as the mean value on the first day of successive analytical periods is presented below (cf. Fig. 8).

Another limitation of the research is the use of data for both the primary and secondary markets (the research used data for both the secondary and primary market without dividing the market into these two segments). Using data for both markets together may cause some bias, which may appear according to lag in the primary market. Recent research indicates that data from the primary real estate market should be analyzed with a lag of 2 quarters due to the length of the investment process in this market (Hill et al., 2021).

The values calculated for the same dataset with the use of the geometric mean are lower than those obtained with the arithmetic mean. In the proposed algorithm, the geometric mean is applied in the denominator; therefore, the values of the index are higher when calculated with the geometric mean than the arithmetic mean. When $DC_s$ is extrapolated to the cumulative increase $DC_{sd}$, a considerable shift in the results is observed in the long term (12 years, 144 months, 48 quarters), whereas the dynamics of the index remains unchanged.

![Fig. 9. $DC_{sd}$ values calculated with the arithmetic mean and the geometric mean on a quarterly basis. Source: own study.](image-url)

The differences in the results generated by the geometric mean and the arithmetic mean were presented in an analysis of quarterly data (where the horizontal dimension of the window denotes one quarter). This interval is recommended in the discussed variant for analyzing the real estate market. Monthly data are characterized by excessive variations, whereas annual data are too general. A similar approach to developing the index has been presented in the literature. The house price index developed by the National Bank of Poland relies on quarterly data. The quarterly interval has also been used as the reference period in research studies of the Warsaw housing market (Widlak et al., 2015; Łaszek et al., 2016; Brzezicka et al., 2019).

A robustness test was also designed to validate the effectiveness of the proposed method. The purpose of the test is to determine whether the price and $DC_{sd}$ change in the same direction across the analyzed periods (both categories decrease or increase simultaneously). The differences in both values were calculated across periods, and plus and minus signs were monitored to determine whether the described method accurately reflects the observed changes. The strength of these changes was not determined because the analyzed categories are not comparable – the index is not a simple outcome of the price, and it is developed based on a complex analysis of the processes inside the speculative...
frame. In the robustness test, the effectiveness of the method reached 55% for monthly data (both categories changed in the same direction in 79 periods, and in opposite directions in 64 periods), 62% for quarterly data (29 and 18 periods, respectively), and 82% for annual data (9 and 2 periods, respectively). In each calculation, the number of periods is reduced by one relative to the number of periods adopted for the analysis because one period is eliminated during the calculation of the difference in value. The results are presented in Figure 10 for monthly data, in Figure 11 for quarterly data, and in Figure 12 for annual data.

Fig. 10. Robustness test – monthly data. Source: own study.

Fig. 11. Robustness test – quarterly data. Source: own study.

Fig. 12. Robustness test – annual data. Source: own study.
The main strength of the proposed method is that it can be used as a fast scoring index for evaluating market performance. An analysis of monthly, quarterly and annual data revealed that the method identified major turning points on the market (the end of the housing boom and the beginning of the crisis). The results also account for the overestimation and underestimation of real estate prices as well as changes in market trends, as demonstrated by the robustness test. The described method also has certain limitations. Outlying properties were not eliminated from the database, which could have improved the results. However, in analyses of large datasets, the method proved to be a reliable tool for evaluating the market based on raw data. It should also be noted that the method would be far more useful for analyzing high-frequency and up-to-date information. However, such data are generally lacking on the Polish housing market, where information about real estate transaction data is registered with a substantial delay (2-3 months). As a result, decision makers often work with invalid information, and the choice of analytical method cannot make up for that deficiency. The proposed method was designed to respond to the current situation on the market, but the flow of information on the Polish real estate market leaves much to be desired. For this reason, the method was tested in a period characterized by a rapid price growth due to the formation of speculative bubbles, followed by a decrease in prices on the real estate market (2004-2015). These trends were effectively captured by the described approach. The proposed method also accounts for the varied number of periods and observations in each analyzed time interval. In the presented variant, analyses were conducted in monthly, quarterly and annual intervals. The adopted interval can be adapted to specific research objectives, and both arithmetic and geometric means can be used.

Conclusions
A simplified speculative frame method was proposed in this study. In the discussed approach, house price dynamics are determined by monitoring the magnitude and direction of market phenomena over time. The price increase $DC_s$ is calculated with the use of quotients of the absolute increase in prices, i.e. the differences between the magnitude of the studied phenomena in the analyzed period and the reference period. The application of quotients in the formula supports the identification of a relative increase which is used to determine the magnitude of changes in the studied phenomena. Cumulative increase $DC_{sd}$ is determined for the additive price model. The proposed approach belongs to the group of median house price indices, where a single index is used in each analyzed period to monitor the performance of the real estate market. The method was validated on the example of the housing market in Warsaw, and it covered data for the period of 2004-2015 which was characterized by a dynamic increase in house prices. The designed algorithm effectively diagnosed house prices, and the index was sensitive to price fluctuations. The proposed index can be used as an auxiliary method for monitoring the stages in the lifecycle of speculative price bubbles. It supports rapid decision-making, which is essential for maintaining long-term market equilibrium and financial sector stability.

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